US005552993A

United States Patent [19]

Buchwitz et al.

[11] **Patent Number: 5,552,993**

[45] **Date of Patent: Sep. 3, 1996**

[54] **AUDIO INFORMATION APPARATUS FOR PROVIDING POSITION INFORMATION**

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[73] Assignee: **The United States of America as represented by the Secretary of the Navy**, Washington, D.C.

[21] Appl. No.: **349,757**

[22] Filed: **Dec. 5, 1994**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 335,560, Nov. 7, 1994, Pat. No. 5,495,416.

[51] **Int. Cl.**[6] **G06F 15/50**

[52] **U.S. Cl.** **364/449**; 340/996

[58] **Field of Search** 342/386, 357; 364/450, 443, 361, 449; 340/996; 379/59; 395/2.1

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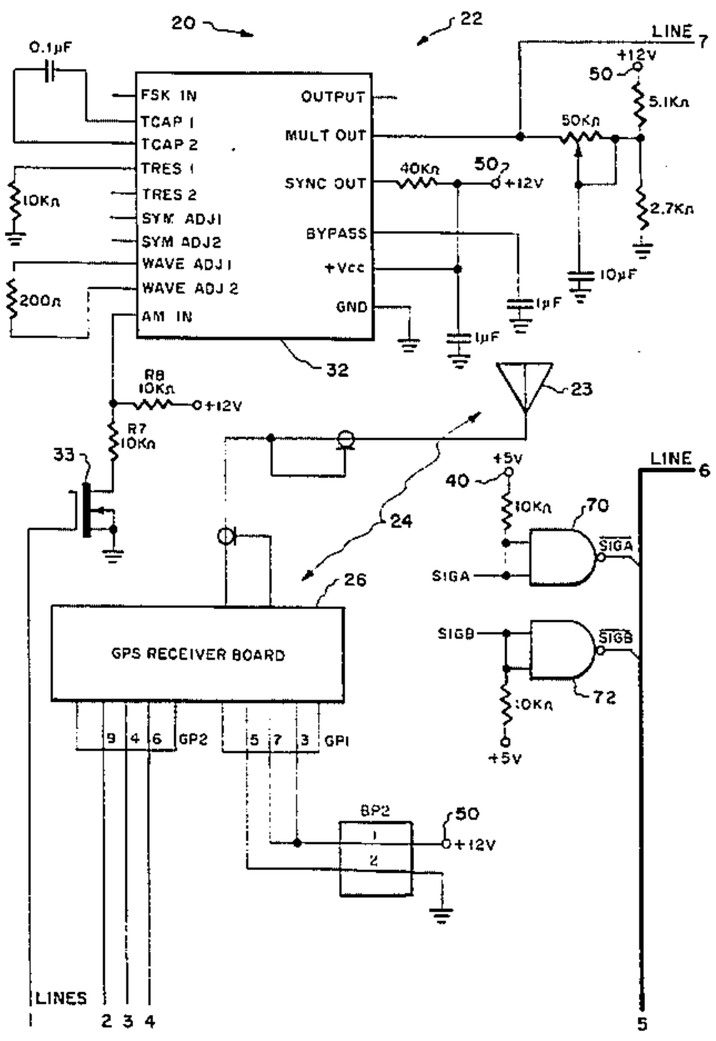
[57] **ABSTRACT**

An audio information apparatus for providing position information as to the location of a target comprising a global positioning system receiver affixed to the target for generating a string of fifty nine ASCII characters representing the latitude and longitude spherical coordinates of the global positioning receiver affixed to the target. The ASCII characters are supplied to a microprocessor, which in response to the ASCII characters, formulates a position message indicating the current location of the global positioning system receiver. A pair of voice recorder/playback circuits, coupled to the microprocessor, have a message table which includes 27 messages or words which when assembled in a predetermined sequence form a longitude and latitude coordinate position message. When the voice recorder/playback circuits are in a message cueing mode, the microprocessor provides a predetermined number of active low chip enable pulses to a selected one of the pair of voice recorder/playback circuits to select the desired word from the table. The microprocessor then disables the message cueing mode which, in turn, enables an audio amplifier of the selected one of the voice recorder/playback circuits. When the microprocessor provides a subsequent chip enable pulse the message is output from the voice recorder/playback circuit to a transmitter for transmission to a ground station. The microprocessor continues this process of utilizing the message cueing mode followed by audio playback addressing mode to output each word of the longitude and latitude coordinate position message from the voice recorder/playback circuits to the transmitter.

17 Claims, 8 Drawing Sheets



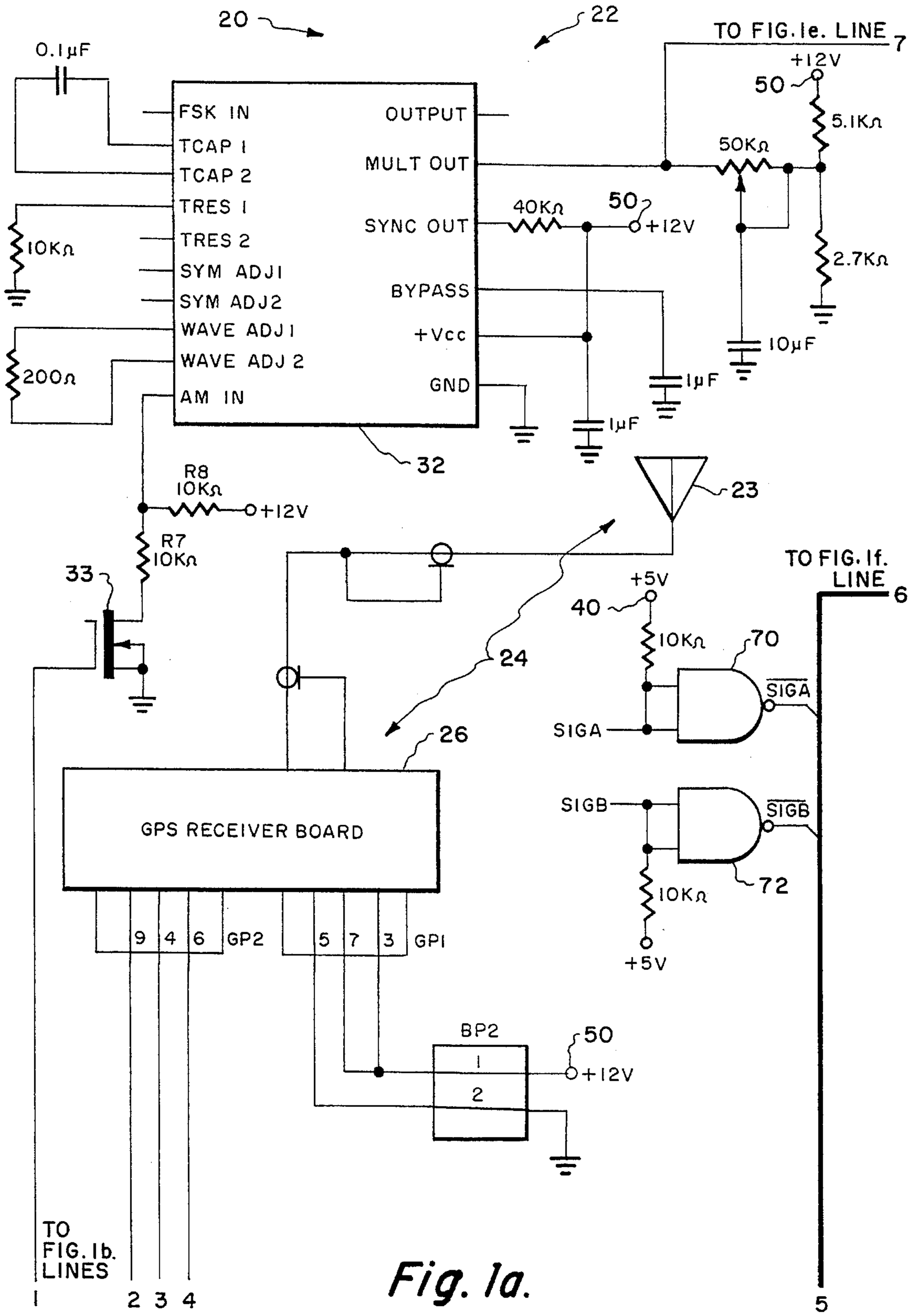

20
22
TO FIG. Ie. LINE 7
0.1µF
FSK IN
TCAP 1
TCAP 2
TRES 1
TRES 2
SYM ADJ1
SYM ADJ2
WAVE ADJ1
WAVE ADJ 2
AM IN
OUTPUT
MULT OUT
SYNC OUT
BYPASS
+Vcc
GND
+12V
50
5.1KΩ
50KΩ
40KΩ
2.7KΩ
10KΩ
200Ω
10µF
1µF
1µF
32
R8
10KΩ
+12V
R7
10KΩ
33
23
TO FIG. If. LINE 6
+5V
40
10KΩ
70
SIGA
SIGA
24
26
GPS RECEIVER BOARD
SIGB
SIGB
72
10KΩ
+5V
9 4 6 GP2
5 7 3 GP1
BP2
50
1
+12V
2
TO FIG. Ib. LINES
1 2 3 4
5

Fig. 1a.

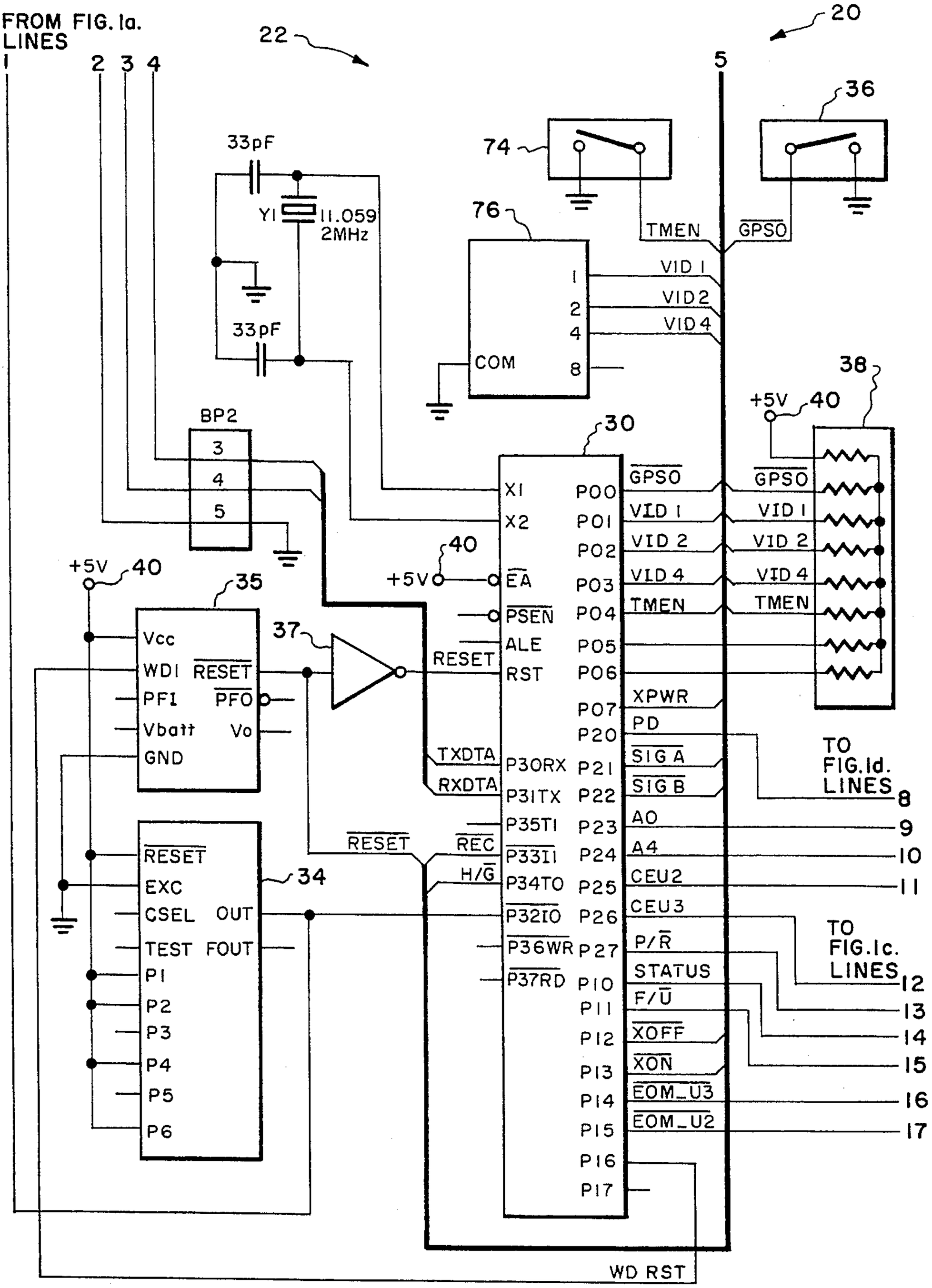

FROM FIG. Ia.
LINES
1 2 3 4
22
33pF
Y1
11.059
2MHz
33pF
20
5
36
74
76
TMEN
GPSO
VID 1
VID2
VID 4
COM
1
2
4
8
38
+5V
40
BP2
3
4
5
30
35
37
34
Vcc
WDI
RESET
PFI
PFO
Vbatt
Vo
GND
X1
X2
EA
PSEN
ALE
RST
P30RX
P31TX
P35TI
P3311
P34TO
P32IO
P36WR
P37RD
P00
P01
P02
P03
P04
P05
P06
P07
P20
P21
P22
P23
P24
P25
P26
P27
P10
P11
P12
P13
P14
P15
P16
P17
TXDTA
RXDTA
REC
H/G
XPWR
PD
SIG A
SIG B
AO
A4
CEU2
CEU3
P/R
STATUS
F/U
XOFF
XON
EOM_U3
EOM_U2
TO FIG.Id. LINES 8 9 10 11
TO FIG.Ic. LINES 12 13 14 15 16 17
EXC
CSEL
OUT
TEST
FOUT
P1
P2
P3
P4
P5
P6
WD RST

Fig. 1b.

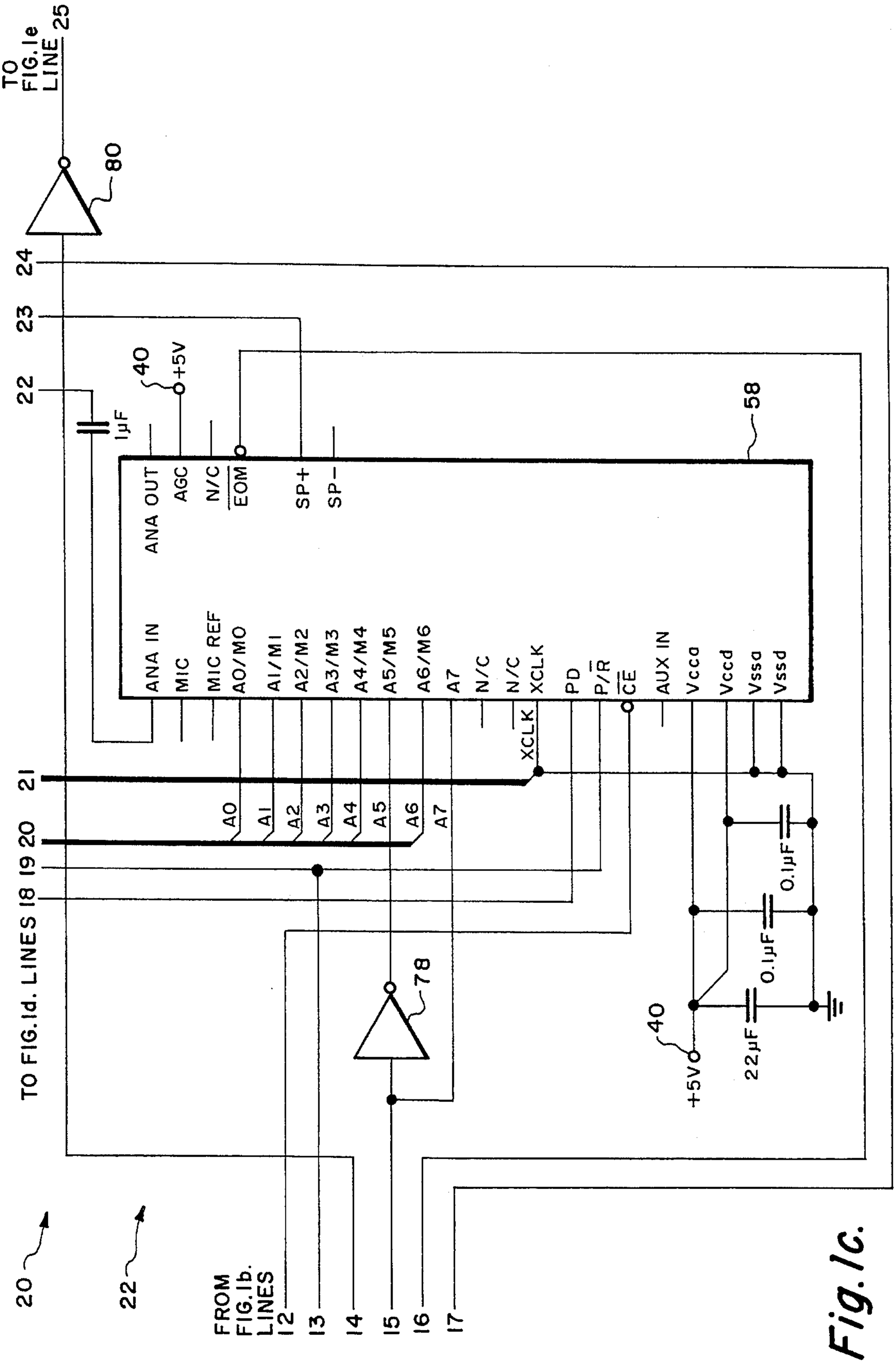

TO FIG. Ie LINE 25
80
24
23
22
40
+5V
1μF
58
ANA OUT
AGC
N/C
EOM
SP+
SP−
ANA IN
MIC
MIC REF
AO/MO
AI/MI
A2/M2
A3/M3
A4/M4
A5/M5
A6/M6
A7
N/C
N/C
XCLK
PD
P/R
CE
AUX IN
Vcca
Vccd
Vssa
Vssd
21
20
19
18
TO FIG. Id. LINES
A0
A1
A2
A3
A4
A5
A6
A7
78
0.1μF
0.1μF
22μF
+5V
40
20
22
FROM FIG. Ib. LINES
12
13
14
15
16
17

Fig. Ic.

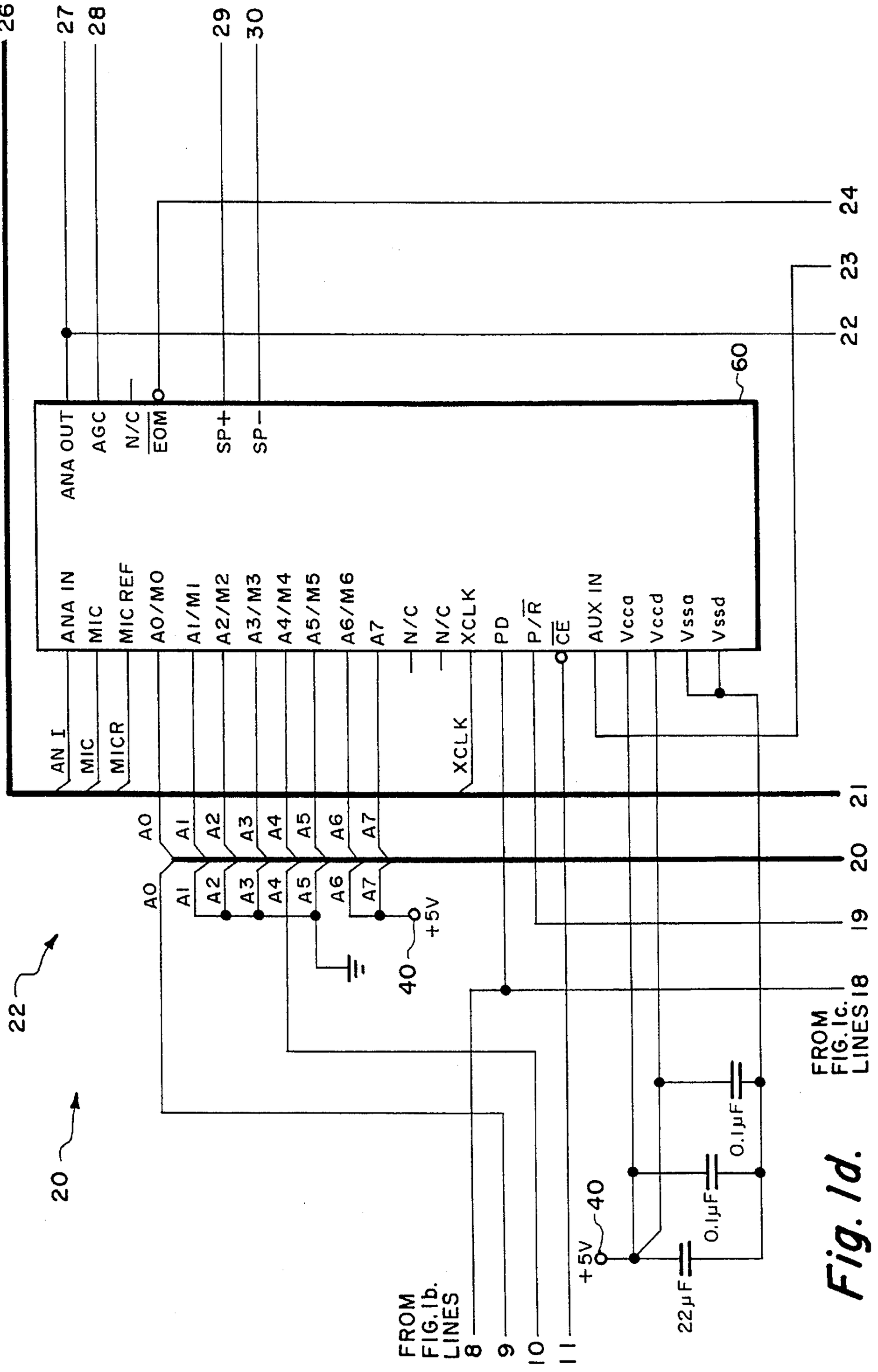

TO FIG. 1e. LINES
26
27
28
29
30
ANA OUT
AGC
N/C
EOM
SP+
SP−
24
23
22
60
ANA IN
MIC
MIC REF
AO/MO
AI/MI
A2/M2
A3/M3
A4/M4
A5/M5
A6/M6
A7
N/C
N/C
XCLK
PD
P/R
CE
AUX IN
Vcca
Vccd
Vssa
Vssd
AN I
MIC
MICR
XCLK
21
20
19
18
AO
AI
A2
A3
A4
A5
A6
A7
+5V
40
22
20
FROM FIG. 1c. LINES
FROM FIG. 1b. LINES
8
9
10
11
0.1µF
22µF

Fig. 1d.

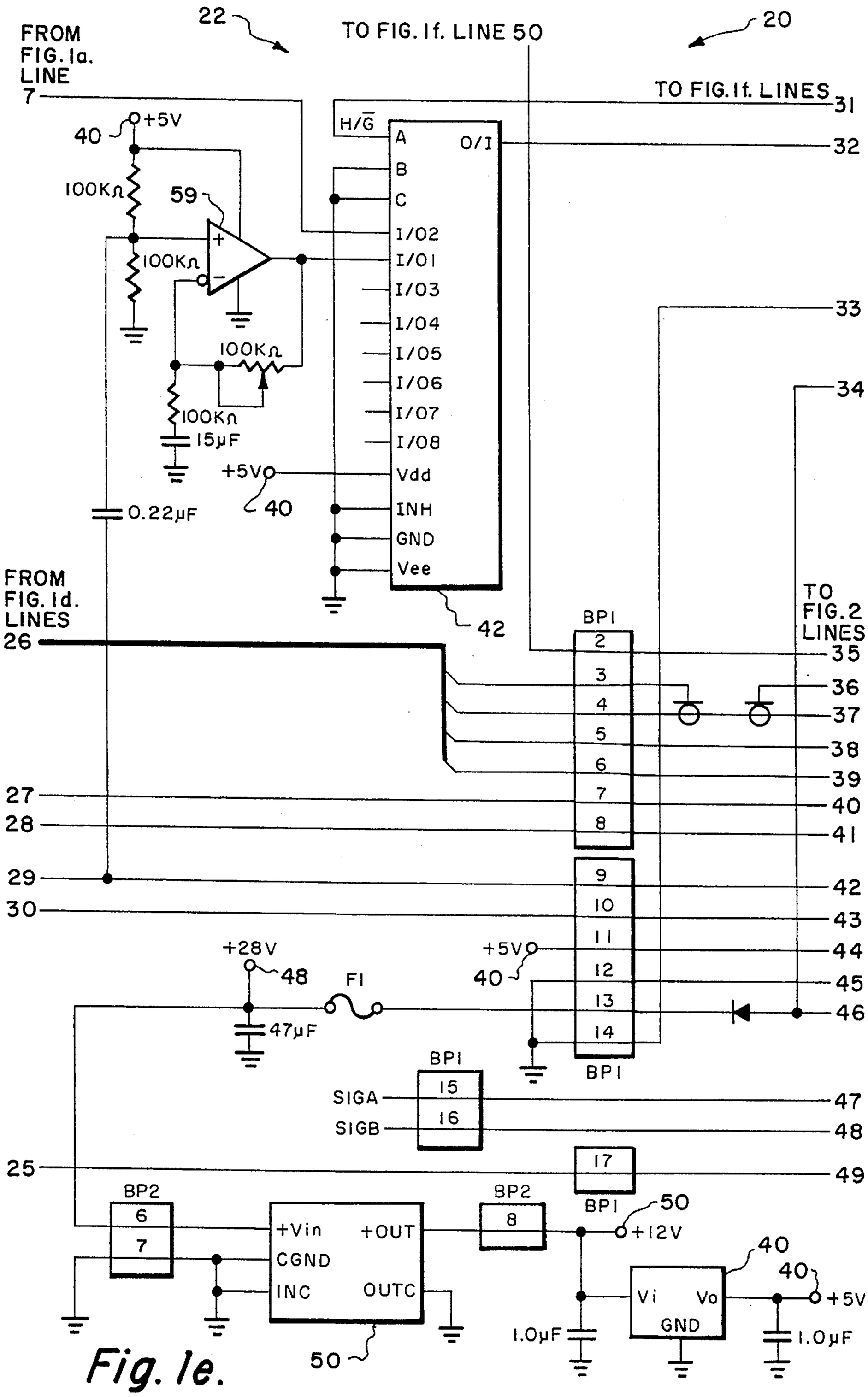

FROM FIG. Ia. LINE 7
22
TO FIG. If. LINE 50
20
TO FIG. If. LINES 31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
H/G
A
B
C
O/I
I/02
I/01
I/03
I/04
I/05
I/06
I/07
I/08
Vdd
INH
GND
Vee
+5V
40
100KΩ
59
100KΩ
100KΩ
100KΩ
15μF
0.22μF
42
FROM FIG. Id. LINES 26
27
28
29
30
25
BP1
BP2
+28V
48
F1
47μF
SIGA
SIGB
+Vin
CGND
INC
+OUT
OUTC
50
+12V
Vi
Vo
GND
1.0μF
1.0μF
TO FIG. 2 LINES

Fig. 1e.

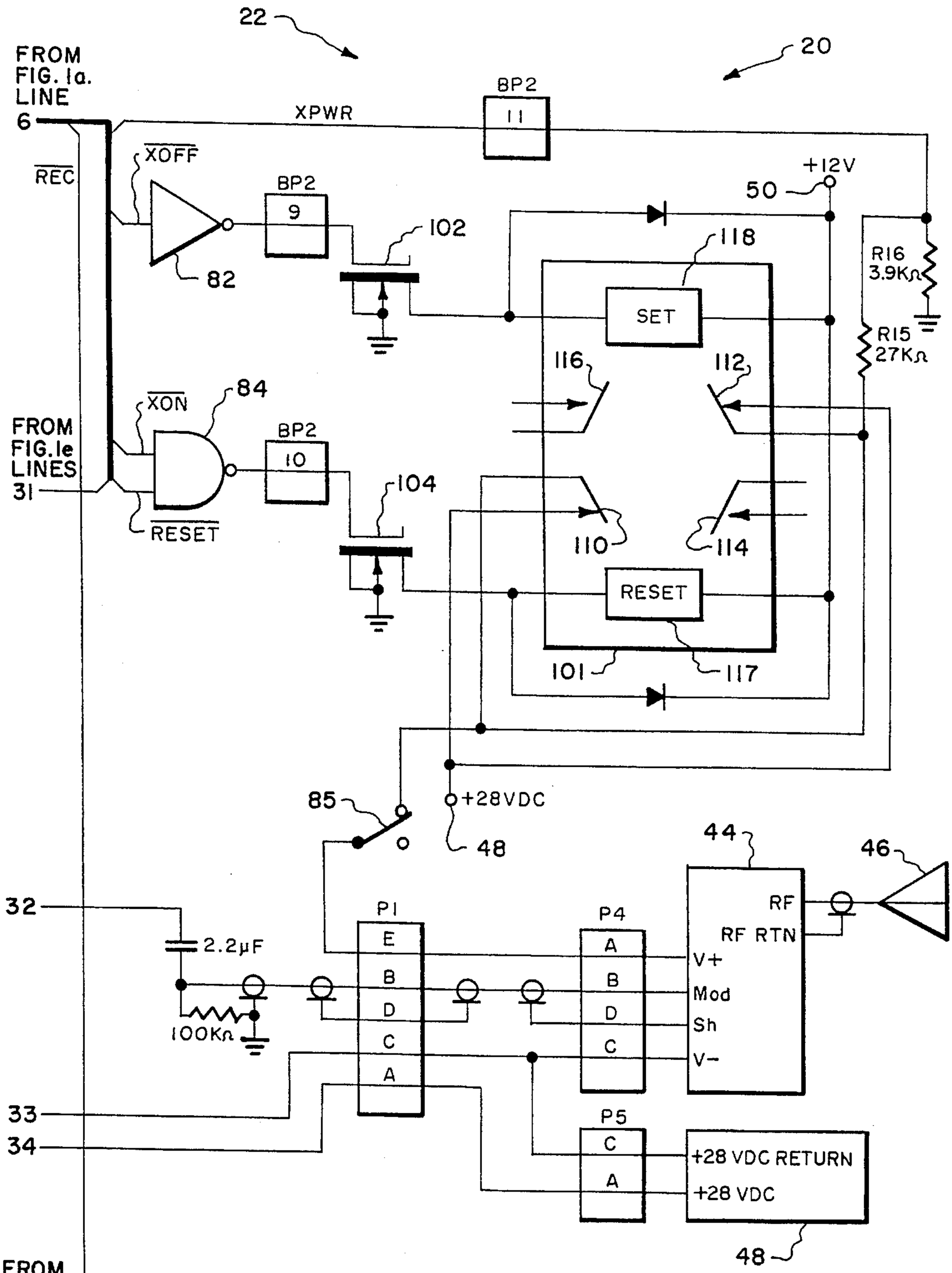

22
20
FROM FIG. Ia. LINE 6
XPWR
BP2
11
XOFF
REC
BP2
9
102
82
+12V
50
118
SET
R16 3.9KΩ
R15 27KΩ
116
112
84
XON
FROM FIG. Ie LINES 31
BP2
10
104
110
114
RESET
101
117
85
+28VDC
48
44
46
32
P1
E
B
D
C
A
2.2μF
100KΩ
P4
A
B
D
C
V+
Mod
Sh
V-
RF
RF RTN
33
34
P5
C
A
+28 VDC RETURN
+28 VDC
48
FROM FIG. Ie. LINE 50

Fig. 1f.

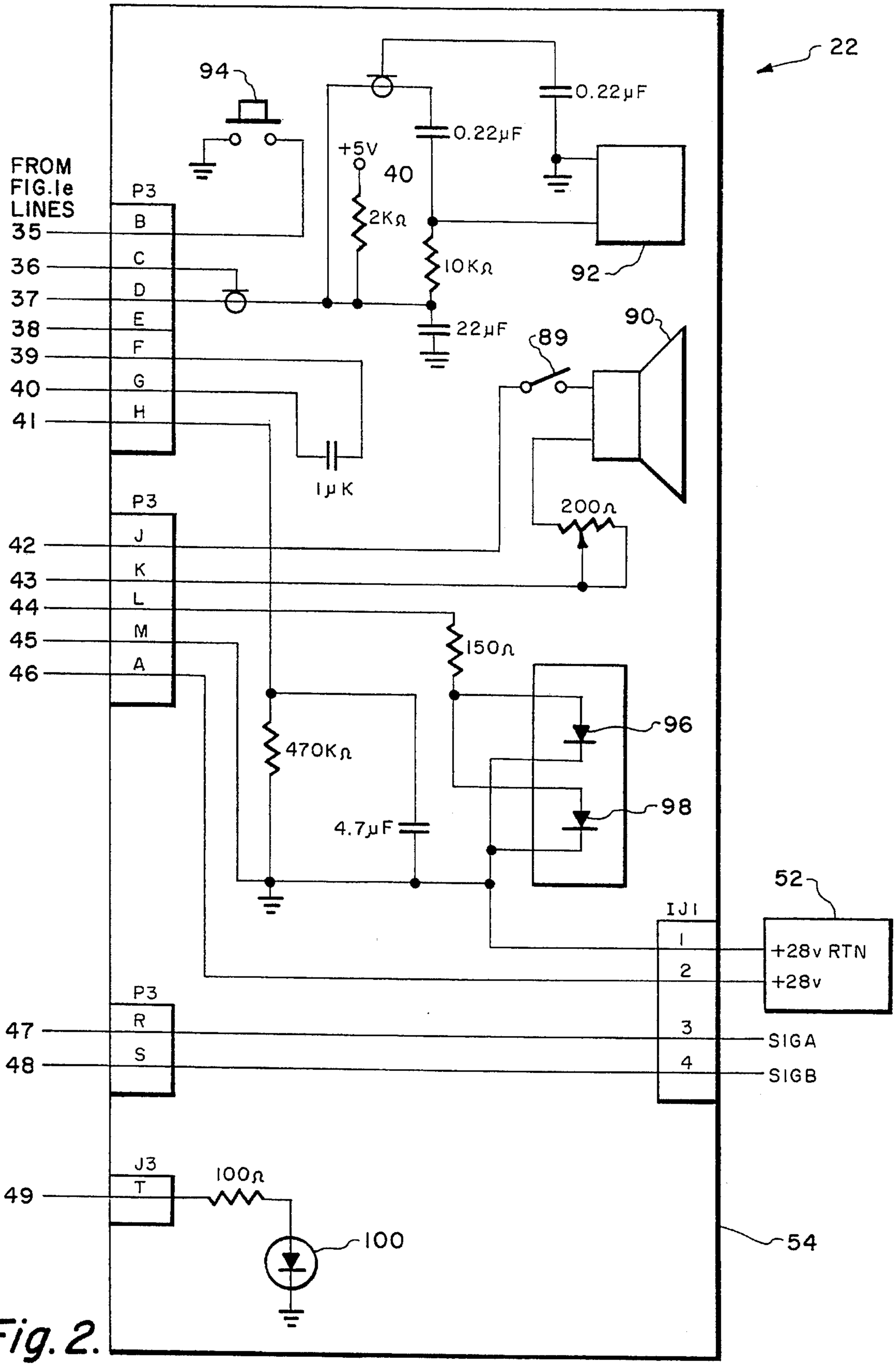

22
94
0.22μF
0.22μF
+5V
40
FROM FIG.1e LINES
P3
35
B
36
C
37
D
38
E
39
F
40
G
41
H
2KΩ
10KΩ
92
22μF
90
89
1μK
P3
42
J
43
K
44
L
45
M
46
A
200Ω
150Ω
470KΩ
4.7μF
96
98
52
IJ1
1
2
3
4
+28v RTN
+28v
SIGA
SIGB
P3
47
R
48
S
J3
49
T
100Ω
100
54

Fig. 2.

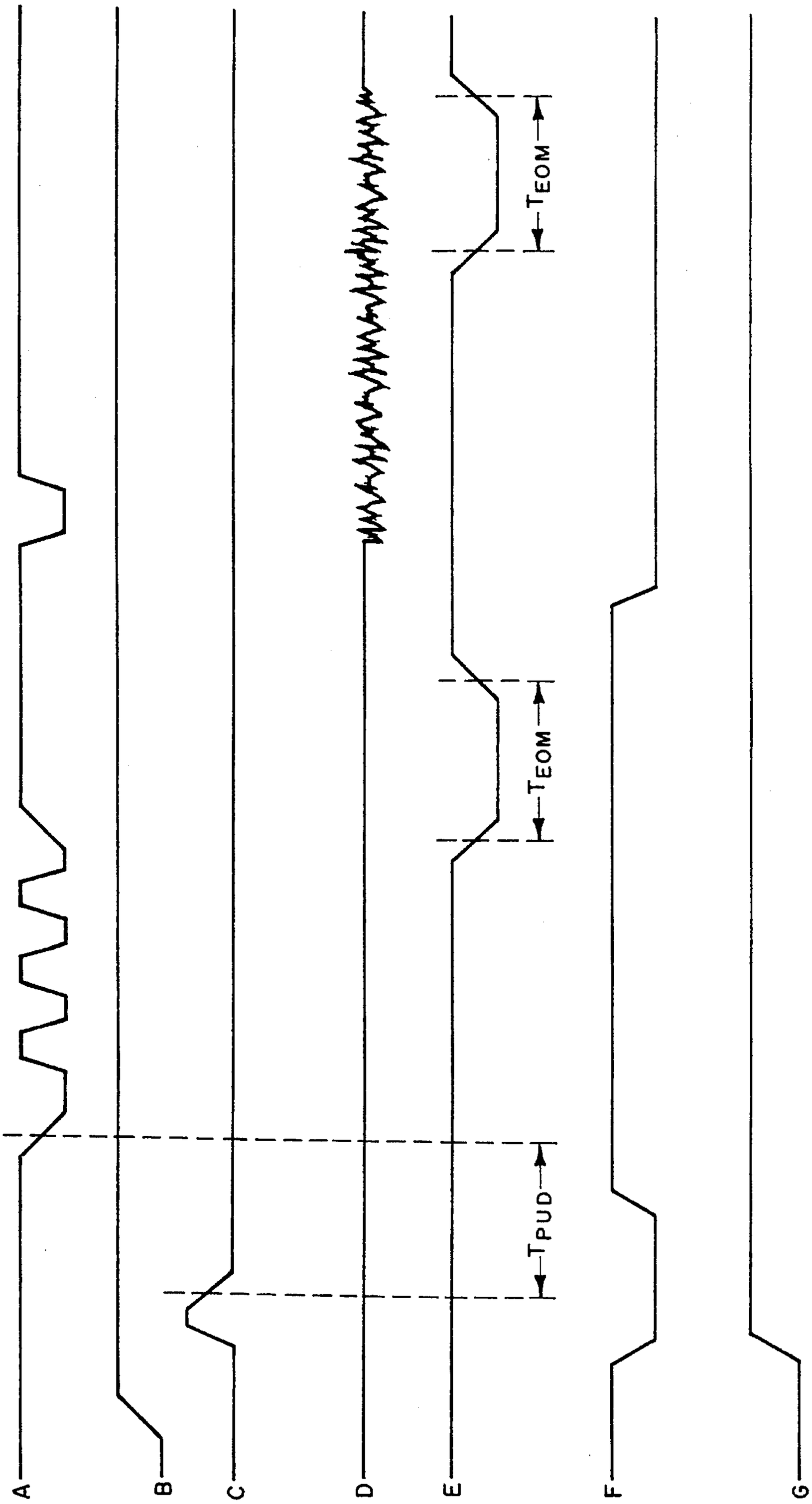


Fig. 3.

AUDIO INFORMATION APPARATUS FOR PROVIDING POSITION INFORMATION

This application is a continuation-in-part of U.S. Ser. No. 335,560, now U.S. Pat. No. 5,495,416, filed Nov. 07, 1994.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to audio information systems and is more particularly concerned with the use of a microprocessor for receiving positional information from a global positioning system receiver and converting the positional information to a digital format for a voice recorder/playback circuit which then provides an analog audio voice signal to a speaker which broadcasts the information.

2. Description of the Prior Art

In the past a variety of systems have been developed to provide audio information to indicate to the user their position or the position of an object that is being tracked by the user. Most such prior art systems which use audio signals or sound as a means for providing position information are relatively simple in design yet these systems are extremely limited as to their end use.

For example, U.S. Pat. No. 4,490,717 discloses a graphic display device which includes a cassette tape recorder which is used as a memory to store graphic data of the drive route. The cassette tape recorder includes a track which is used for voice. The content recorder on the voice track is converted to an electrical signal which is amplified by an amplifier and reproduced as a sound signal from a speaker.

U.S. Pat. No. 4,190,819 discloses a motor vehicle audio information system having a programmable automotive tape recorder that can automatically deliver sequential prerecorded messages concerning road information and the like at predetermined intervals. An electromechanical adapter connected to the odometer system of the vehicle provides pulses that are proportional to the distance traveled and these pulses are fed into a microprocessor which performs arithmetic and logic functions to drive a tape recorder with prerecorded messages. The system permits the distance data for programming the microprocessor and the related sequential message to be stored directly on the tape such as a prerecorded cassette or for the distance data to be stored in the memory of the microprocessor with the sequential messages on the tape only.

There are also in the prior art sophisticated audio systems which provide sound or audio information which is indicative of the position of a craft, either on land, sea or in the air being monitored. One such prior art craft tracking system is disclosed in U.S. Pat. No. 5,153,836. The system of U.S. Pat. No. 5,153,836 allows the position of a plurality of craft, either on land, sea or air to be monitored. Each craft determines its own position using an existing position determining system such as a Global Positioning System. Each craft then transmits a radio frequency signal into which position information, preferably identifying information, and other messages, have been encoded. Each craft broadcast its position, identifying information, and other messages on a regular basis without the need for any interrogation signal. The broadcast position and identification information can be received by other craft and, since each craft has determined its own position, can be used to determine the proximity and identity of other craft. An audio alarm system is provided which is integrated with a computer to apprise the operator of a craft of a potential collision or other situation requiring attention.

While each of these prior art sound or audio systems are generally satisfactory for their intended purpose, that of providing position information to a craft either having such a system or tracking another craft which has an audio system for indicating position, these prior art audio systems have certain limitations. For example, such prior art audio devices for indicating position are generally a built in to the craft which is using the system. In addition, their cost may be prohibitive preventing their use in, for example, automobiles, pleasure boats and small commercial aircraft.

There are also limitations with respect to the flexibility of these prior art audio or sound systems in that the systems require a predetermined or preprogrammed route to be followed by the craft using the system. Deviation from the preprogrammed route will cause system error resulting in the system being of little or no value to the user.

In addition, a number of these prior art audio or sound systems require a high degree of technical skills to operate thus significantly limiting the number of people who could use these systems.

Accordingly, there is a need for small, relatively simple in design, relatively inexpensive and highly reliable audio system which provides accurate position information to the user of a craft having such a system. Further, there is a need for a highly reliable audio system which when attached to a target indicates to the user of a craft tracking the target the exact location of the target.

SUMMARY OF THE INVENTION

With the present invention, the foregoing problems are substantially solved. The present invention comprises an audio information apparatus for providing position information as to the location of a target or a vehicle comprising a global positioning system receiver affixed to the target for generating a string of fifty nine ASCII characters representing the latitude and longitude spherical coordinates of the global positioning receiver affixed to the target. The fifty nine ASCII characters are supplied to a microprocessor, which in response to the fifty nine ASCII characters formulates a position message indicating the current location of the global positioning system receiver.

A pair of voice recorder/playback circuits, coupled to the microprocessor, have a message table which includes 27 messages or words which when assembled in a predetermined sequence form a longitude and latitude coordinate position message. When voice recorder/playback circuits are in a message cueing mode, the microprocessor provides a predetermined number of active low chip enable pulses to a selected one of the pair of voice recorder/playback circuits to select the desired words from the table. The microprocessor then disables the message cueing mode which, in turn, enables an audio amplifier of the selected one of the voice recorder/playback circuits. When the microprocessor provides a subsequent chip enable pulse the message is output from the voice recorder/playback circuit to a transmitter for transmission to a ground station or a target recovery vessel/chopper.

The microprocessor continues this process of utilizing the message cueing mode followed by audio playback addressing mode to output each word of the longitude and latitude coordinate position message from the voice recorder/playback circuits to the transmitter. The voice recorder/playback circuits provide an analog audio voice signal to the trans-

mitter which conveys the longitude and latitude spherical coordinates for the current location of the global positioning system receiver. A mode may be selected by which a one kilohertz homing tone burst signal is sent to the transmitter between position messages.

During testing, the analog audio voice signal is also supplied to a speaker. The speaker then broadcasts the exact location of the global positioning system receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1***a*, **1***b*, **1***c*, **1***d*, **1***e* and **1***f* are a detailed electrical schematic of the electronics circuitry for the audio information apparatus for providing position information which constitutes the present invention;

FIG. **2** is a detailed electrical schematic of the record/test circuit of the present invention; and

FIGS. **3**A–**3**G are timing waveforms illustrating the signals required to effect the broadcasting of an "ALERT TONES" message by the audio information apparatus of FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIGS. **1***a*, **1***b*, **1***c*, **1***d*, **1***e* and **1***f* there is shown the electronics circuit **20** for the audio information apparatus **22** constituting the present invention. Audio information apparatus **22** receives position data from at least three global positioning system satellites, not shown, which is supplied to the antenna **23** of a global positioning system receiver **24**. Global positioning system receiver **24** includes antenna **23** and a global positioning system receiver board **26** which outputs position data in a TTL digital format via the TXDTA line to a microprocessor **30**. There is also a RXDTA line connecting microprocessor **30** to global positioning system receiver board **26** allowing microprocessor **30** to communicate with receiver board **26**. Microprocessor **30** provides a message to receiver board **26** via the RXDTA line requesting latitude and longitude positional data as well as a universal time code.

The global positioning system receiver board **26** selected for use in the present invention is a Magellan OEM GPS 5000 Receiver, Part No. 00-85000-000 manufactured by Magellan Systems Corporation of San Dimas, Calif. Receiver board **26** conforms to the NMEA (National Marine Electronics Association) 0183 software protocol for controlling data flow between receiver board **26** and microprocessor **30**.

Referring to the computer program listing of Appendix A for the software of microprocessor **30**, which is set forth in Appendix A, receiver board **26** provides a fixed message to microprocessor **30**. This fixed message conveys longitude and latitude positional data from receiver board **26** to microprocessor **30**. This fixed message is a series of fifty nine ASCII characters which for each ASCII character includes a start bit, eight data bits and a stop bit. The start bit is a logic zero and the stop bit is a logic one. The message also includes a checksum which is computed as each of the characters is provided to microprocessor **30** and then compared with a checksum provided with the message to verify that an error did not occur during message transmission.

The software of Appendix A initializes the P30RX serial input of microprocessor **30** to a baud rate of 9600 baud. Each ASCII character input to the P30RX serial input of microprocessor **30** generates an interrupt. The program counter of microprocessor **30** upon receiving the interrupt vectors to the interrupt service routine beginning at line 554 (SERIAL_PORT_ISR) of the software of Appendix A. If the stop bit is correct "(bit #**10**)=1" (line 561 of the software of Appendix A), a jump occurs to line 566 (STOP_BIT_OK) where a check is made to determine whether a "$" character has been received by microprocessor **30**. If the received character is a "$", then a new message is being provided by receiver board **26**.

When the received character is a "$" the received character counter and the receiver character buffer pointer within microprocessor **30** are initialized. The pointer when initialized points to a starting address within the receive buffer of RAM memory of microprocessor **30** within which latitude position data (RBUF_LAT_ 10D, line 1112 of Appendix A) from global positioning system receiver **24** is stored. The pointer is then incremented to allow for the storage of each additional ASCII character of longitude and latitude position data (lines 1112–1145 of Appendix A) from global positioning system receiver board **26** within the receive buffer of microprocessor **30**.

When the stop bit is not a logic one a bit or flag is set indicating that there is a stop bit error. When the message is complete the software looks for any stop bit errors which have occurred during message transmission from receiver board **26**.

The message from global positioning system receiver board **26** includes fifty nine ASCII characters which provides the longitude and latitude position information for the current location of global positioning system receiver **24**. Lines 578–585 of the software of Appendix A insure that only fifty nine characters of position information are processed by microprocessor **30**.

If less than sixty characters are received by microprocessor **30**, than the software of Appendix A jumps to line 586 (RCHAR_CTR_OK).

At line 587 the software of Appendix A looks up a response code indexed by the received character counter. For each ASCII character received by microprocessor **30** from global positioning system receiver board **26** a response code is assigned with the codes being zero, one, two, three, four, five, six and seven. Based upon the response code in the software of Appendix A for each ASCII character, the software of Appendix A branches to a routine to process the received ASCII character.

The first ASCII character provided to microprocessor **30** by receiver board **26** is "G" (line 592 of Appendix A). The code assigned to the ASCII character "G" is a zero which results in the processing of line 654 of the software of Appendix A. This RESPOND routine moves the ASCII character "G" into checksum with the character "G" being the initial value of a newly computed checksum.

Each successive ASCII character with the exception of the last five ASCII characters (ASCII characters 55–59) are exclusive-ored into the checksum. Thus, for example, the second received ASCII character "P" is exclusive-ored with the character "G". The resulting computed checksum is then stored in the memory location within microprocessor **30** identified as checksum. The received character counter within microprocessor **30** is also incremented by a count of one for each ASCII character received by microprocessor **30**. The incremented count, in turn, indicates the particular routine to be utilized in processing the received ASCII character.

At this time it should be noted that the LOC and OBJ codes are hexadecimal codes. For example at line 585 of the

software of Appendix A the hexadecimal address 0380 has a value of 32 hexadecimal which is the operation code for the return from interrupt instruction.

The ASCII character at line 605 of the software of Appendix A will be utilized for the purpose of illustrating the operation of the response table/lookup table (RESPONSE_TABLE) of Appendix A. The ASCII character at line 605 is the latitude tens of degrees character provided by global positioning system receiver board **26**. The response table for the fourteenth ASCII character assigns a response code of three to the accumulator of microprocessor **30**. The software jumps through the RESPOND, RESPOND_TO_1, and RESPOND_TO_2 to the RESPOND_TO_3 routine at line 674. The ASCII character is then exclusive-ored into the checksum and saved, and the received character buffer pointer is incremented.

The fifty fifth received ASCII character from receiver board **26** is an the character "*" (line 646 of the software of Appendix A). This character which is not processed by the software of Appendix A functions as a delimiter. The fifty sixth received character is the checksum ASCII tens value. The code of six (line 647) in the response table causes the software of Appendix A to jump to the RESPOND_TO_6 routine (line 707). The RESPOND_TO_6 routine converts the checksum ASCII tens value into its hexadecimal numerical equivalent. The fifty seventh received character which is the checksum ASCII units value is converted to its hexadecimal numerical equivalent by the RESPOND_TO_7 routine which begins at line 715 of the software of Appendix A. A comparison is then made between the checksum provided by characters 56 and 57 and the computed checksum. If the comparison between the checksum provided by characters 56 and 57 and the computed checksum is not equal a jump occurs (line 718) to the DO_NOT_TRANSFER routine at line 739 of the software of Appendix A.

Whenever a flag is set indicating a stop bit error (line 719) the software of Appendix A also proceeds to the DO_NOT_TRANSFER routine at line 739 of the software of Appendix A.

When the checksum is validated and a stop bit error flag is not set, then the longitude and latitude position data is transferred to a transmit buffer within microprocessor **30**. The only position data supplied to the transmit buffer within microprocessor **30** is data with a response codes of three and four. This position data includes latitude data with a response code of three which is in tens of degrees (line 605), degrees (line 606), tens of minutes (line 607), minutes (line 608), tenths of minutes (line 610) and hundredths of minutes (line 611). North or South latitude direction (line 613) is also provided by receiver board **26** to microprocessor **30** and then transferred to the transmit buffer within microprocessor **30**. The response code for the North or South latitude direction ASCII character is four.

The position data also includes longitude data which is in hundreds of degrees (line 615), tens of degrees (line 616), degrees (line 617), tens of minutes (line 618), minutes (line 619), tenths of minutes (line 621) and hundredths of minutes (line 622). East and West longitude direction (line 624) is also provided by receiver board **26** to microprocessor **30** and then transferred to the transmit buffer within microprocessor **30**. The response code for the East or West longitude direction ASCII character is four. The remaining data provided by receiver board **26** is not transferred to the transmit buffer within microprocessor **30**.

At this time it should be noted that the microprocessor **30** used in the preferred embodiment of the present invention is 87C51H 8-bit CMOS microcontroller commercially available from INTEL corporation of Santa Clara, Calif.

Referring again to FIGS. **1***a*, **1***b*, **1***c* and **1***d* circuit **20** also includes a sinewave oscillator **32** which provides at its MULT OUT output a 1 KHz sinewave signal which is modulated by a one hertz square wave signal supplied to sinewave oscillator **32** by a programmable crystal oscillator **34**. When the one hertz square wave signal is high, a field effect transistor **33** is turned on causing a voltage drop of about six volts across a resistor R8. This +6 VDC signal is supplied to the AM IN input of sinewave oscillator **32** turning off the MULT OUT output of sinewave oscillator **32**. When the one hertz square wave signal is low transistor **33** is turned off which results in +12 VDC being supplied to the AM IN input of sinewave oscillator **32** turning on the MULT OUT output of sinewave oscillator **32**. This six volt swing in voltage at the AM IN input of sinewave oscillator **32** results in a modulated 1 KHz sinewave signal occurring at the MULT OUT output of sinewave oscillator **32**.

This modulated 1 KHz sinewave signal allows the user of audio information apparatus **22** to track a target having apparatus **22** attached thereto to track and recover the target by homing in on the 1 KHz modulated sinewave signal.

When a switch **36** is closed thereby connecting the **P00** input of microprocessor **30** to ground which provides a logic zero to the **P00** input of microprocessor **30** only longitude and latitude position coordinates are broadcast/transmitted by audio information apparatus **22**. This, in turn, conserves power since transmitter **44** is on only when audio information apparatus **22** is broadcasting longitude and latitude position coordinates.

When it is required to broadcast/transmit both longitude and latitude position coordinates, the 1 KHz modulated sinewave signal switch **36** is opened setting the **P00** input of microprocessor **30** to the logic one state. Circuit **20** includes pull up resistors **38** with each resistor **38** having one terminal connected to a voltage regulator **40** and its opposite terminal connected to an input **P00–P06** of microprocessor **30**. Voltage regulator **40**, in turn, insures that a logic one will be supplied to **P00–P06** inputs of microprocessor **30** whenever the **P00–P06** inputs are not held low.

The one hertz square wave provided by oscillator **34** is also supplied to the/**P32I0** input of microprocessor **30** which uses the one hertz square wave to count the number of seconds between messages selected by microprocessor **30** for a pair of voice recorder/playback circuits **58** and **60**.

Microprocessor **30** controls the broadcasting/transmission of position data and the 1 KHz modulated sinewave signal by audio information apparatus **22**. When microprocessor **30** provides at its **P34T0** output (H//G line) a logic one, the logic one is supplied to the A input of an eight channel analog demultiplexer **42**. This logic one enables the I/O2 input/output of demultiplexer **42** allowing the 1 KHz modulated sinewave signal from oscillator **32** to pass through demultiplexer **42** to transmitter **44** for transmission by an antenna **46** to a ground station or the like.

When microprocessor **30** provides at its **P34T0** output (H//G line) a logic zero, the logic zero is supplied to the A input of demultiplexer **42**. This logic zero enables the **I/O1** input/output of demultiplexer **42** allowing latitude and longitude position data to pass through demultiplexer **42** to transmitter **44** for transmission by an antenna **46** to a ground station or the like.

It should be noted that whenever a system failure occurs audio information apparatus **22** defaults to a mode of operation wherein only the modulated 1 KHz sinewave

signal is transmitted/broadcast by audio information apparatus **22**.

An external 28 volt DC power supply **48** supplies +28 VDC to audio information apparatus **22** through a fuse F1 to the +Vin input of a DC/DC converter **50**. Converter **50** then supplies +12 VDC to voltage regulator **40** which, in turn, provides +5 VDC to a number of the logic elements of electronics circuit **20**. Converter **50** is also connected to oscillator **32** supplying +12 VDC to oscillator **32**. Power supply **48** may be, for example, a battery or some other external power source placed in a target which is using audio information apparatus **22**.

When power is first turned on a microprocessor supervisory circuit **35** will receive +5 VDC from voltage regulator **40**. Microprocessor supervisory circuit **35** then holds its /RESET output at the logic zero state for about fifty milliseconds. This logic zero is supplied to the input of an inverter **37** which provides a logic one RESET signal to microprocessor **30** resetting microprocessor **30**. Microprocessor **30** also supplies a WD RST signal (watch dog reset), which must change logic state at least every one second, to the WDI input of microprocessor supervisory circuit **35**. Whenever the WD RST signal remains either high or low for more than 1.6 seconds microprocessor supervisory circuit **35** provides a/RESET pulse to inverter **37** which inverts the pulse and then supplies the inverted /RESET pulse to microprocessor **30** resetting microprocessor **30**.

A separate 28 volt DC power supply **52** (FIG. **2**) is supplied to record/test circuit **54** (FIG. **2**) when record/test circuit **54** (FIG. **2**) is used to record position data onto voice recorder/playback circuits **58** and **60** or test electronics circuit **20**.

Electronics circuit **20** includes a binary coded decimal switch **76** which is used for target/vehicle identification and allows for seven targets to be coded by using switch **76**. It should be noted that whenever it is desired to record non-user-defined messages on voice recorder/playback circuits **58** and **60** of audio information apparatus **22**, the output lines VID**1**, VID**2** and VID**4** of switch **76** are set to one which is position "0" on switch **76**.

There is also a switch **74** which is not currently being utilized. This switch when open results in a logic one to the P**04** input of microprocessor **30** which indicates to the microprocessor **30** to provide a digital burst of data in accordance with a predetermined format which includes the coordinates of specialized receiving systems.

A pair of external discrete logic signals SIGA and SIGB are also provided to audio information apparatus **22** through record/test circuit **54** to NAND gates **70** and **72** which buffer and invert these signals. The inverted logic signals /SIGA and /SIGB are next supplied respectively to the P**21** and P**22** inputs of microprocessor **30**. These signals may, for example, be used with a salt water detector within a target to determine whether the target is immersed under water. These signals may also be used to indicate whether a target's parachute is deployed.

There is an XPWR signal supplied to the P**07** input of microprocessor **30** which indicates whether transmitter enable switch **85** is receiving +28 VDC. A voltage divider circuit formed by resistors R15 and R16 which are respectively 27 Kilohms and 3.9 Kilohms supplies a +5 VDC signal to the P**07** input of microprocessor **30** when transmitter enable switch **85** is connected to +28 VDC by relay **101**.

When a logic zero /XON pulse is supplied to the first input of a NAND gate **84** by microprocessor **30**, NAND gate **84** will invert this pulse to a logic one pulse which momentarily turns on field effect transistor **104**. Turning on field effect transistor **104** provides for current flow from source **50** through transistor **104** to ground energizing the RESET coil **117** of relay **101**. Energizing the RESET coil **117** of relay **101** closes contacts **110** and **112** of relay **101** providing +28 VDC power to transmitter enable switch **85**. When switch **85** is closed +28 VDC is supplied to transmitter **44**. This turns on power to transmitter **44** allowing transmitter **44** to transmit via antenna **46** position information from circuits **58** and **60** at a frequency within, for example, the radio frequency range which includes generally above 150 KHz to about 3000 gigahertz.

In a like manner, an active low /RESET pulse provided to the second input of NAND gate **84** turns on field effect transistor **104** which energizes the RESET coil **117** of relay **101**. This also provides +28 VDC power to transmitter enable switch **85**.

When a logic zero/XOFF pulse is supplied to the input of an inverter **82** by microprocessor **30**, inverter **82** will invert this pulse to a logic one pulse which momentarily turns on field effect transistor **102**. Turning on field effect transistor **102** provides for current flow from source **50** through transistor **102** to ground energizing the SET coil **118** of relay **101**. Energizing the SET coil **118** of relay **101** closes contacts **114** and **116** of relay **101** which disconnects +28 VDC from transmitter enable switch **85**. It should be noted that transmitter enable switch **85** must be in the closed position before energizing the RESET coil of relay **101** which will then allow +28 VDC to power transmitter **44**

It should be noted that whenever audio information apparatus **22** is providing only longitude or latitude position coordinates, relay **101** is used to conserve power by turning on transmitter **44** when position messages are being transmitted and turning off transmitter **44** when position messages are not being transmitted. It should also be noted that when the modulated 1 KHz sinewave signal either alone or in combination with position messages are being transmitted by transmitter **44**, power to transmitter **44** is not turned off.

The voice recorder/playback circuits **58** and **60** used in the preferred embodiment of the present invention are Model No. ISD1020A Single_Chip Voice Record/Playback Devices commercially available from Information Storage Devices of San Jose, Calif. The microprocessor supervisory circuit **35** is a Model MAX690 supervisory circuit commercially available from Maxim Integrated Products of West Peabody, Mass. The programmable crystal oscillator **34** is a Model PXO-600 Programmable Crystal Oscillator commercially available from Statek Corporation of Orange, Calif. The sinewave oscillator **32** is a Model XR-2206 Monolithic Function Generator manufactured by EXAR Integrated Systems, Inc. of Sunnyvale, Calif.

Operational modes of voice recorder/playback circuits **58** and **60** are enabled by taking address pins A**7** and A**6** high or at the logic one state. The states of address pins A**5** through A**0** determine control function and not the message address. The following table shows the operational modes of voice recorder/playback circuits **58** and **60** with each mode being selected by bringing the appropriate address high.

TABLE I

Function	Address Control (High)
Message cueing (See note 1)	A0

TABLE I-continued

Function	Address Control (High)
End-Of-Message markers are deleted by the next message use with A4 = 1	A1
During playback, End-Of-Message pulses low at array overflow only	A2
Continuous playback	A3
Consecutive addressing - Message start pointer is reset only when operational mode is changed (See note 2)	A4
Playback is chip enable level activated	A5

Note 1.
Message cueing allows the user to skip through messages. Each time /CE memory is pulsed low with the address inputs set to this mode, the internal message pointer skips forward until it encounters an end-of-message marker and then stops. By providing a certain number of pulses to the /CE pin in message cuing mode and then changing to consecutive addressing mode, the user can select and then record or playback a desired message.
Note 2.
Consecutive addressing allows for recording and playback of consecutive messages without the need for direct addressing or any other kind of message management. During recording, each time that /CE is taken low, a message is recorded at the next position in memory. When /CE is taken high again, an end-of-message marker is written to indicate the position of the end of message. In this fashion a string of messages is recorded, each one placed immediately after the previous one.

Referring to FIGS. **1***a*, **1***b*, **1***c*, **1***d*, **1***e*, **1***f* and **2** and the computer software listing of Appendix A, the operation of audio information apparatus **22** in the playback mode will now be discussed.

Audio information apparatus **22** transmits longitude and latitude position information every two minutes. Beginning at line **314** (POWER_UP_XMTR) the transmitter **44** is powered up. The H//G line is cleared to the logic zero state by microprocessor **30** thereby providing a logic zero to the A input of demultiplexer **42** enabling its I/O**1** input/output. Enabling the I/O**1** input/output of demultiplexer **42** allows latitude and longitude position data to pass through demultiplexer **42** to transmitter **44** for transmission by an antenna **46**.

The transmitter **44** is next turned on by energizing the RESET coil of relay **101** which, when transmitter enable switch **85** is closed, results in +28 VDC being provided to transmitter **44** (line 316). The P//R line is brought to the logic one state, FIG. **3**C, by microprocessor **30** (line 317) resulting in logic ones at the P//R inputs of voice recorder/playback circuits **58** and **60**. An inter-position timer within microprocessor **30** is set for a two minute time period which is the time period between the start of each message transmission by audio information apparatus **22**.

Beginning at line 321 of Appendix A alert tones are transmitted by audio information apparatus **22** by moving an address 15 hexadecimal (line 24) into a message variable and call a subroutine PLAY_MESSAGE subroutine (line 805). At line 805 a ten second time period is provided by microprocessor **30** to transmit the message by insuring that the WD RST signal (watch dog reset) changes logic state approximately every one second. This, in turn, prevents microprocessor supervisory circuit **35** from providing a /RESET pulse. The message variable 15 hexadecimal is next moved into the accumulator of microprocessor **30**.

The first byte from the MESSAGE TABLE, which is four hexadecimal for ALERT_TONES (line 841), is loaded into the accumulator (line 810). The first byte indicates to microprocessor **30** the number of /CE pulses required for the particular message which will be transmitted by audio information apparatus **22**.

The second byte from the MESSAGE_TABLE, which is three for ALERT_TONES (line 841), is also loaded into the accumulator (line 815). The second byte indicates to microprocessor **30** the voice recorder/playback circuits **58** or **60** having the message "ALERT TONES" stored therein. When the second byte is two the message is stored in circuit **60** and when the second byte is three the message is stored in circuit **58**. Each byte of the message is stored in a variable VRPD message pointer (lines 811 and 816).

The microprocessor **30** clears to the logic zero state the A**0** line, FIG. **3**F, assuming that message cuing is not required (line 849) for voice recorder/playback circuits **58** and **60**. Microprocessor **30** next sets the A**4** line, FIG. **3**G, to the logic one state which selects the consecutive address mode of operation for circuits **58** and **60**. The PD (power down) line is first set to the logic one state, FIG. **3**B, by microprocessor **30** resetting both VRPD message pointers and then cleared to the logic zero state by microprocessor **30**. This also resets the address counters within voice recorder/playback circuits **58** and **60** to zero. The software of Appendix A provides for a thirty five millisecond power up delay identified as T_{PUD} in FIG. **3** (lines 853 and 854).

At line 855 the device number which is either circuit **58** or circuit **60** is moved to the accumulator. Since the device number for the message ALERT_TONES is voice recorder/playback circuit **58** a jump to line 881 occurs at line 856.

At line 882 the VRPD_MSG_PTR value is moved to the accumulator of microprocessor **30**. If the value is zero cuing is not required and a jump occurs to line 897 which is PLAY_U3. The message "ZEERO" is stored in circuit **60** at a value of zero hexadecimal, while the message "LONGITUDE" is stored in circuit **58** at a value of zero hexadecimal.

Since the value for the message "ALERT TONES" is not zero the A**0** line is set high by microprocessor **30** and all interrupts are disabled for ten microseconds. At lines 888 and 889 the first /CE pulse, FIG. **3**A, is supplied by microprocessor **30** to the /CE input of voice recorder/playback circuit **58**. This process continues for three additional /CE pulses, FIG. **3**A, since the cueing mode requires four /CE pulses for the "ALERT TONES" message. Microprocessor **30** then detects the logic one to zero transition of the /EOM pulse, FIG. **3**E, supplied by circuit **58** to the P**14** input of microprocessor **30**. An approximately 17 millisecond time out is provided at line 892 and 892 of Appendix A. This time out is identified as T_{EOM} in FIG. **3**. It should be noted that holding A**0** high in the cueing mode prevents circuits **58** and **60** from providing an analog audio voice signal at their SP+ and SP– outputs as is best illustrated by FIG. **3**D.

At line 895 a loop is provided within the software until the value in a register R5 within microprocessor **30** is decremented to zero. In line 884 the number of /CE pulses required for the "ALERT TONES" message is loaded into register R4 with this number being four.

At line 896 the cueing mode is disabled by clearing the A**0** line, FIG. **3**F, allowing circuit **58** to provide the message "ALERT TONES" at its SP+ and SP– outputs. At lines 898–900 microprocessor **30** clears, sets and clears again the /CEU**3** line generating a /CE pulse, FIG. **3**A, which results in playback of the message "ALERT TONES", FIG. **3**D, by voice recorder/playback circuits **58**. The software loops until the /EOM signal, FIG. **3**E, first transitions to the logic zero state and then transitions to the logic one state. When the rising edge of the /EOM signal, FIG. **3**E, is detected by microprocessor **30** the software returns to line 324 which is the SEND_VEHICLE_ID subroutine. At lines 325 and

326, the message "TARGET" is transmitted by audio information apparatus **22** in exactly the same manner as the message "ALERT TONES" by using the PLAY_MESSAGE subroutine. At line 328 a position update flag is cleared. The position update flag which is set at line 730 indicates that a valid position message was received from global positioning system receiver board **26** by microprocessor **30**.

The target ID bits are next read from binary coded decimal switch **76** by microprocessor **30** for transmission by audio information apparatus **22**. At line 334 the PLAY_MESSAGE subroutine is called to allow audio information apparatus **22** to transmit the target identification which may be a number between one and seven.

At line 335 the status of global positioning system receiver board **26** is checked. Until a longitude and latitude position data is provided by receiver board **26**, receiver board **26** supplies zeros to microprocessor **30**. Whenever microprocessor **30** is receiving only zeros from receiver board **26**, audio information apparatus **22** transmits the message "NO GPS" using the PLAY_MESSAGE subroutine (lines 337 and 338) followed by the message "POSITION" again using the PLAY_MESSAGE subroutine (lines 339 and 340).

Whenever receiver board **26** provides valid longitude and latitude position data to microprocessor **30**, a jump occurs at line 336 to line 343 of Appendix A. If receiver board **26** supplies new longitude and latitude position coordinates to microprocessor **30** a jump occurs to line 347, otherwise audio information apparatus **22** transmits the message "LAST" using the PLAY_MESSAGE subroutine (lines 345 and 346).

Audio information apparatus **22** next transmits the message "POSITION" (lines 348 and 349). A five second delay is next provided in the software of Appendix A. A pointer **R0** is initialized to the first address (#TBUF_START) in the transmit buffer of microprocessor **30** which has the current longitude and latitude position coordinates to be transmitted by audio information apparatus **22**.

At lines 352–366 of Appendix A, audio information apparatus **22** first transmits two digits of a latitude position coordinate followed by the message "DEGREES"; two digits of latitude whole minutes followed by the message "POINT"; two digits of latitude hundredths of minutes followed by the message "MINUTES" and the direction North or South followed by the message "LATITUDE". A one second delay is next provided by the software of Appendix A before transmission of the longitude position coordinate.

At lines 368–382 audio information apparatus **22** transmits up to three digits of a longitude position coordinate followed by the message "DEGREES"; two digits of longitude whole minutes followed by the message "POINT"; two digits of longitude hundredths of minutes followed by the message "MINUTES" and the direction East or West followed by the message "LONGITUDE". A one second delay is next provided by the software of Appendix A after transmission of the longitude position coordinate.

At lines 348–399 of Appendix A, audio information apparatus **22** transmits the logic state of SIGA and the logic state of SIGB which is either one or zero.

At line 402 audio information apparatus **22** transmits a user-defined message which has an address of seventy one hexadecimal in voice recorder/playback circuit **58**. The PLAY_USER_MESSAGE subroutine, which begins at line 758 of Appendix A, is called to effect the transmission of the user defined message. Used registers are saved (line 759) and the PD line is cleared by microprocessor **30** (line 762). At line 763, there is a thirty five millisecond delay before microprocessor **30** sets the P//R line high selecting playback mode for voice recorder/playback circuits **58** and **60**. Microprocessor **30** next clears to the logic zero state the F//U line which is high for fixed messages and low for user defined messages. Lines 766–768 of the software provide an address of seventy one hexadecimal which is the address for the user defined message in circuit **58**. A /CE pulse is next supplied to the /CE input of voice recorder/playback circuit **58** which then provides at its SP+ and SP– outputs an analog audio voice signal of the user defined message. The analog audio voice signal is then supplied through buffer **59** and demultiplexer **42** to transmitter **44** for transmission via antenna **46** to a ground station or the like.

It should be noted that closing switch **89** of record/test circuit **54** connects speaker **90** to voice recorder/playback circuits **58** and **60** allowing speaker **90** to broadcast the user defined message.

It should also be noted that record/test circuit **54** includes a status light emitting diode **100** which indicates to the user of audio information apparatus **22** that apparatus **22** is transmitting, for example, a longitude and latitude coordinate position message or a user defined message.

Audio information apparatus **22** allows user defined messages or messages of the type set forth at lines **20** through **36** of Appendix A to be recorded on voice recorder/playback circuits **58** and **60** by using microphone **92** and record button **94**. Beginning at line **184** the software of Appendix A checks to determine whether audio information apparatus **22** is in a record mode (CHECK_FOR_RECORD_MODE). Whenever the output lines VID**1**, VID**2**, and VID**4** of binary coded decimal switch **76** are at the logic one state a jump occurs to line 218 (POWER_UP_VRPD). The watch dog timer **35** is set for a time period of 120 seconds. Microprocessor **30** next sets the PD line to the logic one state and then sets /CEU**2** and /CEU**3** lines to the logic one state (lines 219–222) followed by a 0.1 second delay (line 223).

At lines 224–226 microprocessor **30** clears the PD line and then clears the A**0** and A**4** lines to the logic zero. Voice recorder/playback circuits **58** and **60** are now operational and are placed in a direct addressing mode. The status light emitting diode **100** is turned on to indicate to the user of audio information apparatus **22** that apparatus **22** is ready to record. At lines 232–235 the output lines VID**1**, VID**2** and VID**4** of switch **76** are again checked to determine whether the output lines are logic ones. Since microprocessor **30** complements/inverts the output lines VID**1**, VID**2** and VID**4** of switch **76** a jump occurs at line 236 only when the output lines VID**1**, VID**2** and VID**4** of switch **76** are not logic ones.

When a jump does not occur at line 236, a user defined message record interrupt is disabled. Disabling the user defined message record interrupt prevents the program counter from vectoring to an interrupt service routine which records the user defined message when record button **94** is pressed.

Light emitting diode **100** is activated by calling the FLICKER_STATUS_LED subroutine at line 790 of Appendix A. The software next enters a loop (WRITE_PROTECT_CHECK) which allows the user of audio information apparatus **22** to jump from a recording mode by changing at least one of the output lines VID**1**, VID**2**, and VID**4** of switch **76** to the logic zero state. By changing at least one output line of switch **76** the user exits the loop and jumps to J_POWER_UP_XMTR at line 244.

The software will also exit WRITE_PROTECT_CHECK whenever record button **94** is pressed which results in a logic zero being supplied to the /P33I1 input of microprocessor **30**. A jump is provided within the software of Appendix A to line 249 which is PREPARE_TO_RECORD.

At line 250 internal counters within voice recorder/playback circuits **58** and **60** are reset to a hexadecimal address of zero by microprocessor **30**. At line 251 voice recorder/playback circuits **58** and **60** are re-enabled when the PD line is cleared to a logic zero state by microprocessor **30**, followed by a 35 millisecond delay. Microprocessor **30** sets the A4 line high enabling the consecutive address mode for circuits **58** and **60** and then clears A0 which disables the cueing address mode for circuits **58** and **60**. Microprocessor **30** next clears the P//R line to the logic zero state which places voice recorder/playback circuits **58** and **60** in a record mode.

A message pointer is initialized to zero and a sixty seconds time period is provided to record a message within voice recorder/playback circuits **60**. The software loops until a logic zero is supplied to the /P33I1 input of microprocessor **30** by pressing record button **94** which connects ground to the P33I1 input of microprocessor **30**. The software of Appendix A also provides for a debounce time period of 100 milliseconds (lines 261 and 262).

At line 264, microprocessor **30** clears the /CEU2 line which begins the recording of a message within circuit **60** and then turns on light emitting diode **100**. The software continues to loop until either record button **94** is released or circuit **60** provides a logic zero through its /EOM output to microprocessor **30**. It should be noted that circuits **58** and **60** provide a logic zero at their /EOM outputs whenever their capacity of twenty seconds of recording time is exceeded.

When the user releases record button **94** after recording the message a jump occurs to STOP_U2_RECORDING. Microprocessor **30** then sets the /CUE2 line to the logic one state which ends the recording of the message, followed by a 17 millisecond delay and turns off light emitting diode **100**.

At line 278 the message pointer is incremented to record the next message. When the number of messages recorded within voice recorder/playback circuit **60** has not exceeded ten hexadecimal messages, the software returns to line 258 to record the next message.

When ten hexadecimal messages are recorded in voice recorder/playback circuit **60**, microprocessor **30** flickers light emitting diode **100** twice indicating to the user of apparatus **22** that ten hexadecimal messages have been recorded within voice recorder/playback circuit **60**. In a like manner, messages are recorded in voice recorder/playback circuit **58** (lines 286–312 of Appendix A).

At line 313 a jump occurs to line 205 (TEST_ALL_MESSAGES). TEST_ALL_MESSAGES plays via speaker **90** the recorded messages at lines 20–36 of Appendix A and the user defined message which is directly addressed at seventy one hexadecimal.

When the record button is pressed and INT1 is enabled (line 408 of Appendix A) a user defined message may be recorded at hexadecimal address **71** of voice recorder/playback circuit **58**. At line 450 subsequent interrupts from contact bounce of record button **94** are disabled. Used registers are saved (line 451) and the process status word is saved (line 452). In line 452 register bank **2** within microprocessor **30** is selected.

At line 455 the PD line is cleared to the logic zero state which powers up voice recorder/playback circuit **58**, followed by a 100 millisecond time period to debounce the record button **94**. Microprocessor clears the P//R line which places voice recorder/playback circuit **58** in a record mode and then clears the F//U line which selects direct addressing for the user defined message.

Microprocessor **30** next sets the A0 and A4 lines to the logic one state placing the address seventy one hexadecimal on the address lines A0–A7 of voice recorder/playback circuits **58** and **60**. The A7, A6, A5, A4, A3, A2, A1 and A0 inputs of circuits **58** and **60** are respectively 0,1,1,1,0,0,0,1. By using the address 71 hexadecimal recorder/playback circuit **58** has about six seconds of record time for the user defined message.

Microprocessor **30** next clears the /CEU3 line to allow the user to begin recording the message. The software loops until the user releases the record button **94** or until the /EOM_U3 line is asserted, that is the /EOM_U3 line is at the logic zero state.

Microprocessor **30** sets the /CEU3 line high which ends the recording of the user defined message and then turns off light emitting diode **100**. A seventeen millisecond delay is provided by the software of Appendix A and the PD line is set to the logic one state which powers down voice recorder/playback circuits **58** and **60**.

From the foregoing description, it may readily be seen that the present invention comprises a new, unique and exceedingly useful audio information apparatus for providing position information as to the location of a target or the like which constitutes a considerable improvement over the known prior art. Obviously many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

Appendix A

```
MCS-51 MACRO ASSEMBLER      GLS4.ASM                                    10/19/94

DOS 5.0 (038-N) MCS-51 MACRO ASSEMBLER, V2.2
OBJECT MODULE PLACED IN TGLS4.OBJ
ASSEMBLER INVOKED BY:  C:\ICEDIR\ASM51.EXE TGLS4.ASM


LOC  OBJ            LINE     SOURCE

                       1     $DEBUG NOPAGING TITLE(TGLS4.ASM)
                       2
                       3     ;*************************************************************************
                       4     ;
                       5     ;       This is 8751 code for the TGLS4 GPS-to-voice target locating
                       6     ;       system.
                       7     ;
                       8     ;       Written by: Guy R. Buchwitz
                       9     ;            Date: September 22, 1994
                      10     ;         Version: 1.15
                      11     ;
                      12     ;*************************************************************************
                      13     ;       NOTE: Format tabs located at columns #5,10,18,23, and 30
                      14     ;*************************************************************************
                      15     ;
                      16     ;       The following messages are expected to be stored as follows:
                      17     ;       DEVICE     MSG       U2           MSG       U3
                      18     ;        ADDR.    COUNT    MESSAGE       COUNT    MESSAGE
                      19     ;
                      20     ;          0h       0h     "ZEE-RO"       11h     "LONGITUDE"
                      21     ;          1h       1h     "ONE"          12h     "LATITUDE"
                      22     ;          2h       2h     "TWO"          13h     "POSITION"
                      23     ;          3h       3h     "THREE"        14h     "RESET"
                      24     ;          4h       4h     "FOUR"         15h     ALERT TONES
                      25     ;          5h       5h     "FIFE"         16h     "NO GPS"
                      26     ;          6h       6h     "SIX"          17h     "A IS"
                      27     ;          7h       7h     "SEVEN"        18h     "B IS"
                      28     ;          8h       8h     "EIGHT"        19h     "DEGREES"
                      29     ;          9h       9h     "NINER"        1Ah     "MINUTES"
                      30     ;          Ah       Ah     "NORTH"        N/A     USER-DEFINED MESSAGE
                      31     ;          Bh       Bh     "SOUTH"        (UDM directly addressed at 71h)
                      32     ;          Ch       Ch     "EAST"
                      33     ;          Dh       Dh     "WEST"
                      34     ;          Eh       Eh     "TARGET"
                      35     ;          Fh       Fh     "POINT"
                      36     ;         10h      10h     "LAST"
                      37     ;
                      38     ;*************************************************************************
                      39
                      40     ;       Assign symbolic names to constants
00FC                  41             P001_SEC_HI     EQU     0FCh    ;TIMER0 high byte preload for 1ms
0066                  42             P001_SEC_LO     EQU     66h     ;  "    low-byte     "     "   "
                      43                                             ;(11.0592 MHz/12)*0.001 sec = 922
                      44                                             ;(2^16 - 922 = 64,614 = FC66h)
0003                  45             PUD_TIME        EQU     35      ;Allow 35ms for VRPD Power-Up Delay
0011                  46             EOM_TIME        EQU     17      ;Allow 17ms for rise of VRPD EOM following cue
00FD                  47             BAUD_9600       EQU     0FDh    ;TIMER 1 reload value for 9600 Baud (11.0592MHz)
000E                  48             BUF_LENGTH      EQU     14      ;Length of receive/transmit buffers (only 15
                      49                                             ;characters in the GPGGA message convey position)
0078                  50             I_P_TIME        EQU     120     ;Set inter-position time at 120 seconds
000A                  51             GPS_TIME        EQU     10      ;Allow 10 seconds for GPS rcvr response
001A                  52             MESSAGE_MAX     EQU     1Ah     ;Maximum message pointer value
```

```
0087                    53              PCON            EQU     87h     ;ASM51 has no reserved symbol for PCON
                        54
0080                    55              nGPSO   BIT     P0.0    ;(I) Low if only GPS (no homing) info transmitted
0081                    56              nVID1   BIT     P0.1    ;(I) LSB of Vehicle ID
0082                    57              nVID2   BIT     P0.2    ;(I) Mid "      "    "
0083                    58              nVID4   BIT     P0.3    ;(I) MSB of Vehicle ID
0084                    59              TMEN    BIT     P0.4    ;(I) High if tone-coded GPS data is to be sent
0087                    60              XPWR    BIT     P0.7    ;(I) High if xmtr +28 Vdc is output from RLY1
                        61
0090                    62              nSTATUS BIT     P1.0    ;(O) Low to light RTU STATUS LED
0091                    63              F_u     BIT     P1.1    ;(O) High for fixed message, low for user message
0092                    64              nXOFF   BIT     P1.2    ;(O) Pulse low to latch xmtr relay off
0093                    65              nXON    BIT     P1.3    ;(O)   "    "  "    "    "    "   on
0094                    66              nEOM_U3 BIT     P1.4    ;(I) Low when ISD U3 encounters End Of Message
0095                    67              nEOM_U2 BIT     P1.5    ;(I)  "   "    " U2     "       "  "    "
0096                    68              WD_RST  BIT     P1.6    ;(O) Change state every second to avoid reset
                        69
00A0                    70              PD              BIT     P2.0    ;(O) High to power down ISDs U2 and U3
00A1                    71              nSIGA   BIT     P2.1    ;(I) Inverted state of discrete "SIGA"
00A2                    72              nSIGB   BIT     P2.2    ;(I)    "       "  "    "    "SIGB"
00A3                    73              A0              BIT     P2.3    ;(O) Preset before nCEU2/3 for Message Cueing
00A4                    74              A4              BIT     P2.4    ;(O)   "      "       "    "  Consecutive Addr.
00A5                    75              nCEU2   BIT     P2.5    ;(O) Low to enable and latch ISD U2
00A6                    76              nCEU3   BIT     P2.6    ;(O)  "  "    "    "    "    " U3
00A7                    77              P_r             BIT     P2.7    ;(O) High to playback, low to record
                        78
00B0                    79              TXDTA   BIT     P3.0    ;(I) GPS data received via serial port RX
00B1                    80              RXDTA   BIT     P3.1    ;(O) GPS board config sent via serial port TX
00B2                    81              ONE_Hz  BIT     P3.2    ;(I) Falling edge initiates nINT0 each second
00B3                    82              nREC            BIT     P3.3    ;(I) RTU pulls low initiating nINT1 recording ISR
00B4                    83              H_g             BIT     P3.4    ;(O) High gates 1KHz burst, low gates GPS audio
                        84
----                    85              CSEG                            ;Beginning of CODE segment
                        86      BEGIN:
0000                    87              ORG     0000h                   ;Reset vector
0000 020026             88              JMP     INIT
                        89
0003                    90              ORG     0003h                   ;INT0 (1 second) vector
0003 020287             91              JMP     INT0_ISR
                        92
000B                    93              ORG     000Bh                   ;TIMER0 (0.05 second) vector
000B 0202D2             94              JMP     TIMER0_ISR
                        95
0013                    96              ORG     0013h                   ;INT1 (RTU Record) vector
0013 02028E             97              JMP     INT1_ISR
                        98
0023                    99              ORG     0023h                   ;Serial port vector
0023 020345            100              JMP     SERIAL_PORT_ISR
                       101
                       102      INIT:
0026 75815F            103              MOV     SP,#5Fh                 ;Reserve 32 bytes for stack (#60h-7Fh)
0029 75D000            104              MOV     PSW,#00h                ;Reset status flags & select register bank 0
002C 7590FF            105              MOV     P1,#0FFh                ;Set all port pins as inputs (clamp xstr off)
002F 75A0FF            106              MOV     P2,#0FFh
0032 75B0FF            107              MOV     P3,#0FFh
0035 C296              108              CLR     WD_RST                  ;Toggle MAX690 WDI
0037 752F00            109              MOV     RCHAR_CTR,#0
003A 752800            110              MOV     PRE_TICK,#0             ;Init non-changeable TIMER0 ISR 1ms counter
003D 752700            111              MOV     STATUS_LED_TICK,#0      ;Init serial port, RTU status LED counter
0040 752278            112              MOV     WDT,#I_P_TIME           ;Initialize TIMER0 Watch Dog Timer
0043 75230A            113              MOV     SS_WDT,#GPS_TIME        ;Initialize serial set WDT
0046 752400            114              MOV     FIFTY_MS,#0             ;Initialize TIMER0 WDT 50ms counter
0049 7832              115              MOV     R0,#RBUF_START          ;Clear buffers
004B 7941              116              MOV     R1,#TBUF_START
```

```
004D 5A0E          117              MOV     R2,#BUF_LENGTH
                   118      CLEAR_BUF_LOOP:
004F 7600          119              MOV     @R0,#0
0051 08            120              INC     R0
0052 7700          121              MOV     @R1,#0
0054 09            122              INC     R1
0055 DAF8          123              DJNZ    R2,CLEAR_BUF_LOOP
                   124
                   125      INITIALIZE_REGISTERS:
0057 758921        126              MOV     TMOD,#21h
                   127                              ;MODE = 01 - TIMER0 = 16 bits wide
                   128                                ;C/t = 0 - TIMER0 = timer (not a counter)
                   129                               ;GATE = 0 - TIMER0 is not gated
                   130                              ;MODE = 10 - TIMER1 = 8-bit auto-reload (baud rate gen.)
                   131                                ;C/t = 0 - TIMER1 = timer (not a counter)
                   132                               ;GATE = 0 - TIMER1 is not gated
005A 758CFC        133              MOV     TH0,#P001_SEC_HI        ;Initiate TIMER0 for first 1ms int
005D 758A66        134              MOV     TL0,#P001_SEC_LO
0060 758DFD        135              MOV     TH1,#BAUD_9600  ;Init TIMER1 as BRG for 9600 baud
0063 758BFD        136              MOV     TL1,#BAUD_9600  ;... (init standard and auto-reload counters)
0066 75B813        137              MOV     IP,#13h
                   138                                      ;PX0 = 1 - INT0 (1Hz) = higher priority
                   139                                      ;PT0 = 1 - TIMER0 int = higher priority
                   140                                      ;PX1 = 0 - INT1 (nREC) = lower priority
                   141                                      ;PT1 = 0 - TIMER1 int (unused for BRG) = lower priority
                   142                                       ;PS = 1 - SERIAL PORT int = higher priority
                   143                                      ;PT2 = 0 - N/A
                   144                                        ;X = 0 - Reserved
                   145                                        ;X = 0 - Reserved
0069 759870        146              MOV     SCON,#70h
                   147                                       ;RI = 0 - Reset pending serial port receiver int
                   148                                       ;TI = 0 - Reset pending serial port transmitter int
                   149                                      ;RB8 = 0 - Reset pending received stop bit
                   150                                      ;TB8 = 0 - Reset pending transmitted stop bit
                   151                                      ;REN = 1 - Enable serial port receiver
                   152                                      ;SM2 = 1 - Do not set RI unless valid stop bit received
                   153                                      ;SM1 = 1 - 1 start bit (0), 8 data bits, 1 stop bit (1)
                   154                                      ;SM0 = 0 - ...->RB8, variable baud rate (9600)
006C 758855        155              MOV     TCON,#55h
                   156                                      ;IT0 = 1 - INT0 (1Hz)is falling-edge triggered
                   157                                      ;IE0 = 0 - Reset INT0 (1Hz) interrupt flag
                   158                                      ;IT1 = 1 - INT1 (nREC) is falling-edge triggered
                   159                                      ;IE1 = 0 - Reset INT1 (nREC) interrupt flag
                   160                                      ;TR0 = 1 - Enable TIMER0 (0.05 sec)
                   161                                      ;TF0 = 0 - Reset pending TIMER0 overflow flag
                   162                                      ;TR1 = 1 - Enable TIMER1 (BRG)
                   163                                      ;TF1 = 0 - Reset pending TIMER1 overflow flag
006F 75A883        164              MOV     IE,#83h
                   165                                      ;EX0 = 1 - Enable INT0 (1Hz)
                   166                                      ;ET0 = 1 - Enable TIMER0 (0.05 second) interrupt
                   167                                      ;EX1 = 0 - Initially disable INT1 (nREC)
                   168                                      ;ET1 = 0 - Disable TIMER1 (BRG) interrupt
                   169                                       ;ES = 0 - Initially disable serial port interrupt
                   170                                      ;ET2 = 0 - Disable TIMER2 interrupt
                   171                                        ;X = 0 - RESERVED
                   172                                       ;EA = 1 - Globally enable interrupts
                   173
                   174      INITIALIZE_STATUS_FLAGS:
0072 C202          175              CLR     FIRST_POS_RCVD  ;Set upon receipt of 1st valid non-zero position
0074 C203          176              CLR     NON_ZERO_POS            ;Set if non-zero position digit received
0076 C200          177              CLR     POS_UPDATED             ;Set by SERIAL_PORT_ISR on good sentence
0078 C204          178              CLR     LEAVE_LED_ON    ;Set to signal TIMER0 ISR not to turn off LED
007A D296          179              SETB    WD_RST
007C C296          180              CLR     WD_RST
```

```
                    181     INITIALIZE_GPS_RCVR:
007E 1205DC         182             CALL    DLY_P5S         ;Allow 0.5 seconds for GPS rcvr to initialize
0081 1205A4         183             CALL    INIT_GPS_RCVR   ;Send PMGLI message turning on GPGGA message
                    184     CHECK_FOR_RECORD_MODE:
0084 E580           185             MOV     A,P0                    ;Mask target ID (bits 1-3 of P0)
0086 F4             186             CPL     A                       ;Invert the target ID bits
0087 540E           187             ANL     A,#0Eh
0089 603F           188             JZ      POWER_UP_VRPD   ;Jump if VID = 0 (all-message recording)
                    189     ANNOUNCE_RESET:
008B 752C0A         190             MOV     I_P_TIMER,#GPS_TIME     ;Init timer at GPS rcvr grace period
                    191     GPS_WDT_TIMEOUT_LOOP:
008E E52C           192             MOV     A,I_P_TIMER
0090 B401FB         193             CJNE    A,#1,GPS_WDT_TIMEOUT_LOOP ;Transmit homing until last second
0093 C2B4           194             CLR     H_g                     ;Switch to GPS transmission
0095 1205D3         195             CALL    DLY_P1S
0098 752914         196             MOV     MESSAGE,#14h    ;Play "RESET"
009B 1204AB         197             CALL    PLAY_MESSAGE
009E D2B4           198             SETB    H_g                     ;Switch back to homing mode
00A0 752278         199             MOV     WDT,#I_P_TIME
00A3 1205E5         200             CALL    DLY_1S
00A6 1205E5         201             CALL    DLY_1S
00A9 1205E5         202             CALL    DLY_1S
                    203     CHECK_FOR_MESSAGE_TEST:
00AC 20B31B         204             JB      nREC,POWER_UP_VRPD ;Jump if RTU RECORD switch not pressed @pwr up
                    205     TEST_ALL_MESSAGES:
00AF C2B4           206             CLR     H_g                     ;Gate voice modulation to transmitter
00B1 120574         207             CALL    XMTR_ON                 ;Turn on transmitter
00B4 D2A7           208             SETB    P_r                     ;Set for playback mode
00B6 752900         209             MOV     MESSAGE,#0              ;Clear message pointer
00B9 D204           210             SETB    LEAVE_LED_ON
                    211     TEST_MESSAGE_LOOP:
00BB 1204AB         212             CALL    PLAY_MESSAGE            ;Play selected message
00BE 0529           213             INC     MESSAGE                 ;Increment message pointer
00C0 741B           214             MOV     A,#MESSAGE_MAX+1        ;Has MESSAGE incremented beyond its maximum?
00C2 B529F6         215             CJNE    A,MESSAGE,TEST_MESSAGE_LOOP ;Loop for next message if not
00C5 12046A         216             CALL    PLAY_USER_MESSAGE       ;Finally play (direct) user message
00C8 80E2           217             JMP     CHECK_FOR_MESSAGE_TEST ;Loop if another test run is requested
                    218     POWER_UP_VRPD:
00CA 752278         219             MOV     WDT,#I_P_TIME
00CD D2A0           220             SETB    PD
00CF D2A5           221             SETB    nCEU2
00D1 D2A6           222             SETB    nCEU3
00D3 1205D3         223             CALL    DLY_P1S
00D6 C2A0           224             CLR     PD                      ;Take VRPDs out of low-power mode & reset
00D8 C2A3           225             CLR     A0                      ;Deselect VRPD cueing address mode
00DA C2A4           226             CLR     A4                      ;Deselect VRPD consecutive address mode
                    227     FLASH_STATUS_LED:
00DC D204           228             SETB    LEAVE_LED_ON
00DE C290           229             CLR     nSTATUS                 ;Turn on RTU STATUS LED for lamp test
00E0 1205DC         230             CALL    DLY_P5S
00E3 D290           231             SETB    nSTATUS                 ;Terminate lamp test
                    232     CHECK_VEHICLE_ID:
00E5 E580           233             MOV     A,P0                    ;Mask target ID (bits 1-3 of P0)
00E7 F4             234             CPL     A                       ;Invert the target ID bits
00E8 540E           235             ANL     A,#0Eh
00EA 7011           236             JNZ     J_POWER_UP_XMTR ;Jump if VID <> 0 (no all-message recording)
00EC C2AA           237             CLR     EX1                     ;Else disable nREC UDM interrupt
00EE 12049C         238             CALL    FLICKER_STATUS_LED
                    239     WRITE_PROTECT_CHECK:
00F1 30B30C         240             JNB     nREC,PREPARE_TO_RECORD ;ERASE_VRPDS Jump if REC key pressed
00F4 E580           241             MOV     A,P0                    ;Mask target ID (bits 1-3 of P0)
00F6 F4             242             CPL     A                       ;Invert the target ID bits
00F7 540E           243             ANL     A,#0Eh
00F9 7002           244             JNZ     J_POWER_UP_XMTR ;Jump if VID <> 0 (no all-message recording)
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00FB 80F4          245          JMP     WRITE_PROTECT_CHECK     ;Else check again until user is sure
                   246     J_POWER_UP_XMTR:
00FD 02018F        247          JMP     POWER UP XMTR
                   248
                   249     PREPARE_TO_RECORD:
0100 D2A0          250          SETB    PD                      ;Reset VRPDs for recording
0102 C2A0          251          CLR     PD                      ;Re-enable VRPDs
0104 752523        252          MOV     MSEC,#PUD_TIME
0107 120560        253          CALL    DLY_MSEC
010A D2A4          254          SETB    A4                      ;Select VRPD consecutive address mode
010C C2A3          255          CLR     A0                      ;Deselect VRPD cueing address mode
010E C2A7          256          CLR     P_r                     ;Select VRPD record mode
0110 752900        257          MOV     MESSAGE,#0              ;Initialize message pointer
                   258     RECORD_U2_MESSAGES:
0113 75223C        259          MOV     WDT,#60                 ;Allow 60 seconds for message recording
0116 20B3FD        260          JB      nREC,$                  ;Loop until RTU REC key pressed
0119 752564        261          MOV     MSEC,#100               ;Debounce for 100ms
011C 120560        262          CALL    DLY_MSEC
011F 20B3F1        263          JB      nREC,RECORD_U2_MESSAGES
0122 C2A5          264          CLR     nCEU2                   ;Begin recording of message
0124 C290          265          CLR     nSTATUS                 ;Turn on RTU STATUS LED
                   266     RECORD_U2_LOOP:
0126 20B30A        267          JB      nREC,STOP_U2_RECORDING  ;Loop until RTU REC key released
0129 2095FA        268          JB      nEOM_U2,RECORD_U2_LOOP  ;Or until overflow (nEOM_U2 = 0)
                   269     U2_RECORD_OVERFLOW:
012C D2A5          270          SETB    nCEU2                   ;Deselect U2
012E 12049C        271          CALL    FLICKER_STATUS_LED      ;Warn operator to restart at "ZEE-RO"
0131 80CD          272          JMP     PREPARE_TO_RECORD
                   273     STOP_U2_RECORDING:
0133 D2A5          274          SETB    nCEU2                   ;End recording of message
0135 752511        275          MOV     MSEC,#EOM_TIME
0138 120560        276          CALL    DLY_MSEC
013B D290          277          SETB    nSTATUS                 ;Turn off RTU STATUS LED
013D 0529          278          INC     MESSAGE                 ;Increment message counter
013F E529          279          MOV     A,MESSAGE               ;A gets message pointer
0141 B411CF        280          CJNE    A,#11h,RECORD_U2_MESSAGES ;Loop back until ready to record VRPD U3
0144 1205DC        281          CALL    DLY_P5S                 ;Else flicker RTU STATUS LED twice
0147 12049C        282          CALL    FLICKER_STATUS_LED
014A 1205DC        283          CALL    DLY_P5S
014D 12049C        284          CALL    FLICKER_STATUS_LED
                   285
                   286     RECORD_U3_MESSAGES:
0150 75223C        287          MOV     WDT,#60                 ;Allow 60 seconds for message recording
0153 20B3FD        288          JB      nREC,$                  ;Loop until RTU REC key pressed
0156 752564        289          MOV     MSEC,#100               ;Debounce for 100ms
0159 120560        290          CALL    DLY_MSEC
015C 20B3F1        291          JB      nREC,RECORD_U3_MESSAGES
015F C2A6          292          CLR     nCEU3                   ;Begin recording of message
0161 C290          293          CLR     nSTATUS                 ;Turn on RTU STATUS LED
                   294     RECORD_U3_LOOP:
0163 20B30A        295          JB      nREC,STOP_U3_RECORDING  ;Loop until RTU REC key released
0166 2094FA        296          JB      nEOM_U3,RECORD_U3_LOOP  ;Or until overflow (nEOM_U3 = 0)
                   297     U3_RECORD_OVERFLOW:
0169 D2A6          298          SETB    nCEU3                   ;Deselect U3
016B 12049C        299          CALL    FLICKER_STATUS_LED      ;Warn operator to restart at "ZEE-RO"
016E 8090          300          JMP     PREPARE_TO_RECORD
                   301     STOP_U3_RECORDING:
0170 D2A6          302          SETB    nCEU3                   ;End recording of message
0172 D290          303          SETB    nSTATUS                 ;Turn off RTU STATUS LED
0174 0529          304          INC     MESSAGE                 ;Increment message counter
0176 E529          305          MOV     A,MESSAGE               ;A gets message pointer
0178 B41BD5        306          CJNE    A,#MESSAGE_MAX+1,RECORD_U3_MESSAGES ;Loop until VRPDs recorded
017B 1205DC        307          CALL    DLY_P5S                 ;Else flicker RTU STATUS LED three times
017E 12049C        308          CALL    FLICKER_STATUS_LED
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0181 1205DC          309            CALL    DLY_P5S
0184 12049C          310            CALL    FLICKER_STATUS_LED
0187 1205DC          311            CALL    DLY_P5S
018A 12049C          312            CALL    FLICKER_STATUS_LED
018D 01AF            313            JMP     TEST_ALL_MESSAGES
                     314    POWER_UP_XMTR:
018F C2B4            315            CLR     H_g                     ;Gate GPS audio to XMTR modulation
0191 120574          316            CALL    XMTR_ON                 ;Ensure xmtr relay latched on at reset
0194 D2A7            317            SETB    P_r                     ;Select VRPD playback mode
                     318
                     319    INIT_INTER_POS_TIMER:
0196 752C78          320            MOV     I_P_TIMER,#I_P_TIME     ;Initialize inter-position timer
                     321    SEND_ALERT_TONE:
0199 752915          322            MOV     MESSAGE,#15h            ;Transmit alert tones
019C 1204AB          323            CALL    PLAY_MESSAGE
                     324
                     325    SEND_VEHICLE_ID:
019F 75290E          326            MOV     MESSAGE,#0Eh            ;Transmit "TARGET"
01A2 1204AB          327            CALL    PLAY_MESSAGE
01A5 C200            328            CLR     POS_UPDATED             ;Ensure POS_UPDATED is reset for next 30 sec.
01A7 E580            329            MOV     A,P0                    ;Read target ID (bits 1-3 of P0)
01A9 03              330            RR      A                       ;Vehicle ID -> LS 3 bits of ACC
01AA F4              331            CPL     A                       ;Complement inverted input of BCD switch
01AB 5407            332            ANL     A,#7h                   ;Mask off VID number
01AD F529            333            MOV     MESSAGE,A
01AF 1204AB          334            CALL    PLAY_MESSAGE
                     335    CHECK_GPS_STATUS:
01B2 200212          336            JB      FIRST_POS_RCVD,SEND_POSITION ;Jump if valid, non-zero GPS pos received
01B5 752916          337            MOV     MESSAGE,#16h            ;Transmit "NO GPS"
01B8 1204AB          338            CALL    PLAY_MESSAGE
01BB 752913          339            MOV     MESSAGE,#13h            ;Transmit "POSITION"
01BE 1204AB          340            CALL    PLAY_MESSAGE
01C1 1205E5          341            CALL    DLY_1S                  ;Pause
01C4 020235          342            JMP     SEND_A_B
                     343    SEND_POSITION:
01C7 200006          344            JB      POS_UPDATED,SEND_NEW_POSITION ;Jump if pos updated since last xmission
01CA 752910          345            MOV     MESSAGE,#10h            ;Else transmit "LAST"
01CD 1204AB          346            CALL    PLAY_MESSAGE
                     347    SEND_NEW_POSITION:
01D0 752913          348            MOV     MESSAGE,#13h            ;Transmit "POSITION"
01D3 1204AB          349            CALL    PLAY_MESSAGE
01D6 1205DC          350            CALL    DLY_P5S                 ;Pause
01D9 7841            351            MOV     R0,#TBUF_START  ;Init pointer to start of xmit buffer
01DB 7C02            352            MOV     R4,#2                   ;Transmit #degrees latitude
01DD 1205EE          353            CALL    PLAY_R4_TBUF_DIGITS
01E0 752919          354            MOV     MESSAGE,#19h            ;Transmit "DEGREES"
01E3 1204AB          355            CALL    PLAY_MESSAGE
01E6 7C02            356            MOV     R4,#2                   ;Transmit whole minutes latitude
01E8 1205EE          357            CALL    PLAY_R4_TBUF_DIGITS
01EB 75290F          358            MOV     MESSAGE,#0Fh            ;Transmit "POINT"
01EE 1204AB          359            CALL    PLAY_MESSAGE
01F1 7C02            360            MOV     R4,#2                   ;Transmit hundredths of minutes latitude
01F3 1205EE          361            CALL    PLAY_R4_TBUF_DIGITS
01F6 75291A          362            MOV     MESSAGE,#1Ah            ;Transmit "MINUTES"
01F9 1204AB          363            CALL    PLAY_MESSAGE
01FC 1205FA          364            CALL    PLAY_TBUF_DIR   ;Transmit (N)orth or (S)outh
01FF 752912          365            MOV     MESSAGE,#12h            ;Transmit "LATITUDE"
0202 1204AB          366            CALL    PLAY_MESSAGE
0205 1205E5          367            CALL    DLY_1S                  ;Pause after transmitting latitude
0208 7C03            368            MOV     R4,#3                   ;Transmit #degrees longitude
020A 1205EE          369            CALL    PLAY_R4_TBUF_DIGITS
020D 752919          370            MOV     MESSAGE,#19h            ;Transmit "DEGREES"
0210 1204AB          371            CALL    PLAY_MESSAGE
0213 7C02            372            MOV     R4,#2                   ;Transmit whole minutes longiitude
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0215 1205EE              CALL   PLAY_R4_TBUF_DIGITS
0218 75290F              MOV    MESSAGE,#0Fh          ;Transmit "POINT"
021B 1204AB              CALL   PLAY_MESSAGE
021E 7C02                MOV    R4,#2                 ;Transmit hundredths of minutes longitude
0220 1205EE              CALL   PLAY_R4_TBUF_DIGITS
0223 75291A              MOV    MESSAGE,#1Ah          ;Transmit "MINUTES"
0226 1204AB              CALL   PLAY_MESSAGE
0229 1205FA              CALL   PLAY_TBUF_DIR   ;Transmit (E)ast or (W)est
022C 752911              MOV    MESSAGE,#11h          ;Transmit "LONGITUDE"
022F 1204AB              CALL   PLAY_MESSAGE
0232 1205E5              CALL   DLY_1S                ;Pause after transmitting longitude
                 SEND_A_B:
0235 752917              MOV    MESSAGE,#17h          ;Transmit "A IS"
0238 1204AB              CALL   PLAY_MESSAGE
023B 752900              MOV    MESSAGE,#0h           ;Assume nSIGA is high -> Transmit "ZEE-RO"
023E 20A103              JB     nSIGA,SEND_A
0241 752901              MOV    MESSAGE,#1h           ;Else nSIGA is low -> Transmit "ONE"
                 SEND_A:
0244 1204AB              CALL   PLAY_MESSAGE
0247 1205DC              CALL   DLY_P5S               ;Pause
024A 752918              MOV    MESSAGE,#18h          ;Transmit "B IS"
024D 1204AB              CALL   PLAY_MESSAGE
0250 752900              MOV    MESSAGE,#0h           ;Assume nSIGB is high -> Transmit "ZEE-RO"
0253 20A203              JB     nSIGB,SEND_B
0256 752901              MOV    MESSAGE,#1h           ;Else nSIGB is low -> Transmit "ONE"
                 SEND_B:
0259 1204AB              CALL   PLAY_MESSAGE
025C 1205DC              CALL   DLY_P5S               ;Pause
                 SEND_UDM:
025F 12046A              CALL   PLAY_USER_MESSAGE     ;Transmit user-defined message
                 POWER_DOWN_VRPD:
0262 D2A0                SETB   PD                    ;Finished with VRPDs so power them down
0264 C204                CLR    LEAVE_LED_ON
                 ENABLE_RECORD_INT1:
0266 C28A                CLR    IT1                   ;Clear pending INT1 (nREC) interrupt
0268 D2AA                SETB   EX1                   ;Enable INT1 for future user message recording
026A 752278              MOV    WDT,#I_P_TIME   ;Initialize Watch Dog Timer
                 CHECK_GPSO:
026D 208009              JB     nGPSO,ENABLE_HOMING   ;Jump if Homing mode requested
                 GPS_ONLY:
0270 12058F              CALL   XMTR_OFF              ;Else conserve power by powering down transmitter
                 POWER_DOWN_8751:
0273 758701              MOV    PCON,#1h              ;Set IDL bit (CPU stops. Idle stops on interrupt)
                 RESUME_MAIN_LOOP:
0276 02027B              JMP    CHECK_I_P_TIMER ;Main loop resumes here following any ISR
                 ENABLE_HOMING:
0279 D2B4                SETB   H_g                   ;Gate homing modulation to xmtr
                 CHECK_I_P_TIMER:
027B 7478                MOV    A,#I_P_TIME           ;A = #seconds between GPS position transmissions
027D C2D7                CLR    CY                    ;Clear borrow flag
027F 952C                SUBB   A,I_P_TIMER           ;Subtract I_P_TIMER (1Hz) count from I_P_TIME
0281 4002                JC     J_POWER_UP_VRPD ;Loop back to begining if I_P_TIMER underflowed
0283 80EE                JMP    POWER_DOWN_8751 ;Else power down 8751 until next interrupt
                 J_POWER_UP_VRPD:
0285 01CA                JMP    POWER_UP_VRPD   ;POWER_UP_VRPD address outside JC relative range

                 ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

                 ;                                    INTERRUPT SERVICE ROUTINES

                 ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                 ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

                 ;                                    INT0_ISR (1 Hz)
```

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                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                INT0_ISR:
0287 C0D0               PUSH    PSW                     ;Save status word
0289 152C               DEC     I_P_TIMER               ;Count down inter-position timer
028B D0D0               POP     PSW                     ;Restore status word
028D 32                 RETI

                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

                ;                                       INT1_ISR (RTU Record User Message)
                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                INT1_ISR:
028E C2AA               CLR     EX1                     ;Disable subsequent interrupts from contact bounce
0290 C0E0               PUSH    ACC                     ;Save used registers
0292 C0D0               PUSH    PSW
0294 75D010             MOV     PSW,#10h                ;Select register bank 2
                PU_VRPD_FOR_UDM:
0297 C2A0               CLR     PD                      ;Power up VRPDs (U3) for user message
0299 752564             MOV     MSEC,#100               ;Debounce/PUD_TIME = 100ms
029C 120560             CALL    DLY_MSEC
029F C2A7               CLR     P_r                     ;Select VRPD record mode
02A1 C291               CLR     F_u                     ;Select direct address for user message
02A3 D2A3               SETB    A0
02A5 D2A4               SETB    A4
02A7 C2A6               CLR     nCEU3                   ;Else latch address and begin recording
02A9 C290               CLR     nSTATUS                 ;Turn on RTU STATUS LED
02AB D204               SETB    LEAVE_LED_ON
                CHECK_OVERFLOW_LOOP:
02AD 20B303             JB      nREC,END_USER_MESSAGE_RECORDING ;Loop until RTU REC key released
02B0 2094FA             JB      nEOM_U3,CHECK_OVERFLOW_LOOP ;...or until U3's EOM is asserted
                END_USER_MESSAGE_RECORDING:
02B3 D2A6               SETB    nCEU3                   ;End recording of message
02B5 D290               SETB    nSTATUS                 ;Turn off RTU STATUS LED
02B7 C204               CLR     LEAVE_LED_ON
02B9 30B3FD             JNB     nREC,$                  ;Loop until RTU REC key released
02BC 752511             MOV     MSEC,#EOM_TIME
02BF 120560             CALL    DLY_MSEC
02C2 D2A0               SETB    PD                      ;Power down VRPDs
02C4 12046A             CALL    PLAY_USER_MESSAGE       ;Then playback recorded user message
02C7 D291               SETB    F_u                     ;Re-select fixed VRPD addresses
02C9 D0D0               POP     PSW                     ;Restore used registers
02CB D0E0               POP     ACC
02CD C28B               CLR     IE1                     ;Clear any pending nREC INT1
02CF D2AA               SETB    EX1                     ;Renable INT1
02D1 32                 RETI

                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

                ;                                       TIMER0_ISR
                ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                TIMER0_ISR:
02D2 C0E0               PUSH    ACC                     ;Save accumulator
02D4 C0D0               PUSH    PSW                     ;Save status word
02D6 C28C               CLR     TR0                     ;Stop TIMER0
02D8 758CFC             MOV     TH0,#P001_SEC_HI        ;Renitialize TIMER0 counter registers @ 1ms
02DB 758A66             MOV     TL0,#P001_SEC_LO
02DE D28C               SETB    TR0                     ;Enable TIMER0
                CHECK_STATUS_LED:
02E0 300406             JNB     LEAVE_LED_ON,CHECK_STATUS_LED_TICK
02E3 752700             MOV     STATUS_LED_TICK,#0
02E6 0202F2             JMP     CHECK_REL_TIMERS
                CHECK_STATUS_LED_TICK:
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```
02E9 E527              MOV   A,STATUS_LED_TICK
02EB 6005              JZ    CHECK_REL_TIMERS        ;Jump if STATUS_LED_TICK already zero
02ED D52702            DJNZ  STATUS_LED_TICK,CHECK_REL_TIMERS ;Else decrement STATUS_LED_TICK
02F0 D290              SETB  nSTATUS                 ;And turn off STATUS LED if TICK = 0
                 CHECK_REL_TIMERS:
02F2 0526              INC   ONE_MS_TICK             ;Externally-changeable relative 1ms timer counter
02F4 0528              INC   PRE_TICK                ;Non-externally changeable "     "    "    "
02F6 E528              MOV   A,PRE_TICK
02F8 C2D7              CLR   CY
02FA 9432              SUBB  A,#50
02FC 4042              JC    RETURN_FROM_TIMERO_ISR  ;Jump if PRE_TICK < 50
02FE 0510              INC   TICK                    ;Else increment relative 50ms timer counter
0300 752800            MOV   PRE_TICK,#0             ;And reset PRE_TICK
0303 0524              INC   FIFTY_MS                ;Else increment WDT 50ms counter
0305 7414              MOV   A,#20
0307 C2D7              CLR   CY
0309 9524              SUBB  A,FIFTY_MS
030B 5006              JNC   CHECK_WDT               ;Jump if FIFTY_MS <=20
030D 752400            MOV   FIFTY_MS,#0             ;Else reset FIFTY_MS counter
0310 020340            JMP   RETURN_FROM_TIMERO_ISR  ;And our job is done
                 CHECK_WDT:
0313 E523              MOV   A,SS_WDT                ;Pre-check Serial Set Watch Dog Timer
0315 6014              JZ    CHECK_FOR_500MS         ;Do not set WD_RST if SS_WDT timed out
                 CHECK_FOR_300MS:
0317 E524              MOV   A,FIFTY_MS
0319 B40605            CJNE  A,#6,CHECK_FOR_700MS    ;Jump if not at 0.3 seconds
031C D296              SETB  WD_RST                  ;Else set WD_RST
031E 020340            JMP   RETURN_FROM_TIMERO_ISR  ;And our job is done
                 CHECK_FOR_700MS:
0321 B40E07            CJNE  A,#14,CHECK_FOR_500MS   ;Jump if not at 0.7 seconds
0324 D296              SETB  WD_RST                  ;Else set WD_RST
0326 1523              DEC   SS_WDT                  ;Decrement Serial Set Watch Dog Timer
0328 020340            JMP   RETURN_FROM_TIMERO_ISR  ;And our job is done
                 CHECK_FOR_500MS:
032B E522              MOV   A,WDT                   ;Pre-check main program Watch Dog Timer
032D 6011              JZ    RETURN_FROM_TIMERO_ISR  ;Do not reset WD_RST if WDT timed out
032F E524              MOV   A,FIFTY_MS
0331 B40A05            CJNE  A,#10,CHECK_FOR_1000MS  ;Jump if not at 0.5 seconds
0334 C296              CLR   WD_RST                  ;Else reset WD_RST
0336 020340            JMP   RETURN_FROM_TIMERO_ISR  ;And our job is done
                 CHECK_FOR_1000MS:
0339 B41404            CJNE  A,#20,RETURN_FROM_TIMERO_ISR   ;Jump if not at one second
033C C296              CLR   WD_RST                  ;Else output falling edge to MAX 690
033E 1522              DEC   WDT                             ;Decrement Watch Dog Timer
                 RETURN_FROM_TIMERO_ISR:
0340 D0D0              POP   PSW                     ;Restore status word
0342 D0E0              POP   ACC                     ;Restore accumulator
0344 32                RETI                ;And return

                 ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

                 ;                                       SERIAL_PORT_ISR
                 ;IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
                 SERIAL_PORT_ISR:
0345 C0D0              PUSH  PSW                     ;Save register bank 0 (used by all other code)
0347 C0E0              PUSH  ACC
0349 75D008            MOV   PSW,#08h                ;Clear flags and select register bank 1
034C E599              MOV   A,SBUF                  ;Read serial port receive register
034E F52D              MOV   RCHAR,A                 ;Save received character
0350 C298              CLR   RI                      ;Reset serial port interrupt flag
0352 209A07            JB    RB8,STOP_BIT_OK ;Jump if stop bit (bit #10) = 1
0355 D201              SETB  STOP_BIT_ERROR  ;Else indicate data may be erroneous
0357 D0E0              POP   ACC
0359 D0D0              POP   PSW
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035B 32          565            RETI                            ;And return
                 566    STOP_BIT_OK:
035C B42414      567            CJNE    A,#'$',LOOK_UP_RESPONSE ;Jump if nop starting new sentence
035F 753132      568            MOV     RBUF_PTR,#RBUF_START ;Else reset pointers, counters, & flags
0362 752F00      569            MOV     RCHAR_CTR,#0
0365 752E00      570            MOV     CHECKSUM,#0
0368 C201        571            CLR     STOP_BIT_ERROR
036A C200        572            CLR     POS_UPDATED
036C C203        573            CLR     NON_ZERO_POS
036E D0E0        574            POP     ACC
0370 D0D0        575            POP     PSW
0372 32          576            RETI                            ;And return
                 577    LOOK_UP_RESPONSE:
0373 052F        578            INC     RCHAR_CTR               ;Increment index of received characters
0375 E52F        579            MOV     A,RCHAR_CTR             ;Make sure no more than 59 characters received
0377 C3          580            CLR     C
0378 943C        581            SUBB    A,#60
037A 4005        582            JC      RCHAR_CTR_OK            ;Jump if less than 60 characters received
037C D0E0        583            POP     ACC
037E D0D0        584            POP     PSW
0380 32          585            RETI                            ;Else return
                 586    RCHAR_CTR_OK:
0381 E52F        587            MOV     A,RCHAR_CTR             ;Look up response code indexed by RCHAR_CTR
0383 2402        588            ADD     A,#2                    ;Offset PC value by 3 (RCHAR_CTR was already
0385 83          589            MOVC    A,@A+PC                 ;incremented above) to begin table after LJMP
0386 0203C4      590            LJMP    RESPOND                 ;Long Jump (3 bytes) after getting response code
                 591    RESPONSE_TABLE:
0389 00          592                    DB      0       ; 1, G
038A 01          593                    DB      1       ; 2, P
038B 01          594                    DB      1       ; 3, G
038C 01          595            DB      1       ; 4, G
038D 01          596            DB      1       ; 5, A
038E 01          597            DB      1       ; 6, ,
038F 02          598            DB      2       ; 7, UTC hours (tens)
0390 02          599            DB      2       ; 8,  "    "   (units)
0391 02          600            DB      2       ; 9,  "  minutes (tens)
0392 02          601            DB      2       ;10,  "    "   (units)
0393 02          602            DB      2       ;11,  "  seconds (tens)
0394 02          603            DB      2       ;12,  "    "   (units)
0395 01          604            DB      1       ;13, ,
0396 03          605            DB      3       ;14, RBUF_LAT_10D
0397 03          606            DB      3       ;15, RBUF_LAT_D
0398 03          607            DB      3       ;16, RBUF_LAT_10M
0399 03          608            DB      3       ;17, RBUF_LAT_M
039A 01          609            DB      1       ;18, .
039B 03          610            DB      3       ;19, RBUF_LAT_P1M
039C 03          611            DB      3       ;20, RBUF_LAT_P01M
039D 01          612            DB      1       ;21, ,
039E 04          613            DB      4       ;22, RBUF_LAT_DIR
039F 01          614            DB      1       ;23, ,
03A0 03          615            DB      3       ;24, RBUF_LONG_100D
03A1 03          616            DB      3       ;25, RBUF_LONG_10D
03A2 03          617            DB      3       ;26, RBUF_LONG_D
03A3 03          618            DB      3       ;27, RBUF_LONG_10M
03A4 03          619            DB      3       ;28, RBUF_LONG_M
03A5 01          620            DB      1       ;29, .
03A6 03          621            DB      3       ;30, RBUF_LONG_P1M
03A7 03          622            DB      3       ;31, RBUF_LONG_P01M
03A8 01          623            DB      1       ;32, ,
03A9 04          624            DB      4       ;33, RBUF_LONG_DIR
03AA 01          625            DB      1       ;34, ,
03AB 01          626            DB      1       ;35, GPS Availability
03AC 01          627            DB      1       ;36, ,
03AD 01          628            DB      1       ;37, No. of Satellites Used
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03AE 01                 629                     DB      1       ;38, ,
03AF 01                 630                     DB      1       ;39, HDOP
03B0 01                 631                     DB      1       ;40, HDOP
03B1 01                 632                     DB      1       ;41, HDOP
03B2 01                 633                     DB      1       ;42, ,
03B3 01                 634                     DB      1       ;43, Antenna Height
03B4 01                 635                     DB      1       ;44, Antenna Height
03B5 01                 636                     DB      1       ;45, Antenna Height
03B6 01                 637                     DB      1       ;46, ,
03B7 01                 638                     DB      1       ;47, M(eters)
03B8 01                 639                     DB      1       ;48, ,
03B9 01                 640                     DB      1       ;49, Sense of Geoidal Height
03BA 01                 641                     DB      1       ;50, Geoidal Height
03BB 01                 642                     DB      1       ;51, Geoidal Height
03BC 01                 643                     DB      1       ;52, Geoidal Height
03BD 01                 644                     DB      1       ;53, ,
03BE 01                 645                     DB      1       ;54, M(eters)
03BF 05                 646                     DB      5       ;55, *
03C0 06                 647                     DB      6       ;56, CHECKSUM tens
03C1 07                 648                     DB      7       ;57, CHECKSUM units
03C2 05                 649                     DB      5       ;58, CR (0Dh)
03C3 05                 650                     DB      5       ;59, LF (0Ah)
                        651
                        652     RESPOND:
03C4 B40008             653             CJNE    A,#0,RESPOND_TO_1       ;Jump if response code <> 0
03C7 852D2E             654             MOV     CHECKSUM,RCHAR  ;Else character is first in CHECKSUM
03CA D0E0               655             POP     ACC
03CC D0D0               656             POP     PSW
03CE 32                 657             RETI
                        658     RESPOND_TO_1:
03CF B4010B             659             CJNE    A,#1,RESPOND_TO_2       ;Jump if response code <> 1
03D2 E52E               660             MOV     A,CHECKSUM              ;Else character is XOR'd with CHECKSUM
03D4 652D               661             XRL     A,RCHAR
03D6 F52E               662             MOV     CHECKSUM,A
03D8 D0E0               663             POP     ACC
03DA D0D0               664             POP     PSW
03DC 32                 665             RETI
                        666     RESPOND_TO_2:                   ;(SAME AS RESPOND_TO_1)
03DD B4020B             667             CJNE    A,#2,RESPOND_TO_3       ;Jump if response code <> 2
03E0 E52E               668             MOV     A,CHECKSUM              ;Else character is XOR'd with CHECKSUM
03E2 652D               669             XRL     A,RCHAR
03E4 F52E               670             MOV     CHECKSUM,A
03E6 D0E0               671             POP     ACC
03E8 D0D0               672             POP     PSW
03EA 32                 673             RETI
                        674     RESPOND_TO_3:
03EB B4031B             675             CJNE    A,#3,RESPOND_TO_4       ;Jump if response code <> 3
03EE E52E               676             MOV     A,CHECKSUM              ;Else character is XOR'd with CHECKSUM
03F0 652D               677             XRL     A,RCHAR
03F2 F52E               678             MOV     CHECKSUM,A
03F4 A831               679             MOV     R0,RBUF_PTR             ;And copy RCHAR into RBUF
03F6 A62D               680             MOV     @R0,RCHAR
03F8 0531               681             INC     RBUF_PTR                ;Then point to next RBUF location
03FA E52D               682             MOV     A,RCHAR                 ;Check received character (='0'?)
03FC C2D7               683             CLR     CY                      ;Clear borrow flag
03FE 9430               684             SUBB    A,#'0'
0400 6002               685             JZ      RCHAR_EQ_0              ;Jump if position digit = '0'
0402 D203               686             SETB    NON_ZERO_POS            ;Else indicate a non-zero GPS pos digit received
                        687     RCHAR_EQ_0:
0404 D0E0               688             POP     ACC
0406 D0D0               689             POP     PSW
0408 32                 690             RETI
                        691     RESPOND_TO_4:
0409 B40411             692             CJNE    A,#4,RESPOND_TO_5       ;Jump if response code <> 4
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```
040C E52E   693          MOV     A,CHECKSUM              ;Else character is XOR'd with CHECKSUM
040E 652D   694          XRL     A,RCHAR
0410 F52E   695          MOV     CHECKSUM,A
0412 A831   696          MOV     R0,RBUF_PTR             ;And copy RCHAR into RBUF
0414 A62D   697          MOV     @R0,RCHAR
0416 0531   698          INC     RBUF_PTR                ;Then point to next RBUF location
0418 D0E0   699          POP     ACC
041A D0D0   700          POP     PSW
041C 32     701          RETI
            702  RESPOND_TO_5:
041D B40505 703          CJNE    A,#5,RESPOND_TO_6       ;Jump if response code <> 5
0420 D0E0   704          POP     ACC
0422 D0D0   705          POP     PSW
0424 32     706          RETI                            ;Else ignore '*', CR, and LF characters
            707  RESPOND_TO_6:
0425 B4060A 708          CJNE    A,#6,RESPOND_TO_7       ;Jump if response code <> 6
0428 12061D 709          CALL    ASCII_TO_REAL   ;Else convert ASCII checksum tens
042B C4     710          SWAP    A                       ;MSN -> left
042C F9     711          MOV     R1,A                    ;Save for next serial port interrupt
042D D0E0   712          POP     ACC
042F D0D0   713          POP     PSW
0431 32     714          RETI
            715  RESPOND_TO_7:
0432 12061D 716          CALL    ASCII_TO_REAL   ;Convert ASCII checksum units
0435 49     717          ORL     A,R1                    ;Mask LSN into checksum
0436 B52E24 718          CJNE    A,CHECKSUM,DO_NOT_TRANSFER ;Jump if rcvd and calc checksum not =
0439 200121 719          JB      STOP_BIT_ERROR,DO_NOT_TRANSFER
            720  TRANSFER:
043C 7832   721          MOV     R0,#RBUF_START  ;Copy RBUF to TBUF
043E 7941   722          MOV     R1,#TBUF_START
0440 7A0E   723          MOV     R2,#BUF_LENGTH
            724  TRANSFER_LOOP:
0442 E6     725          MOV     A,@R0
0443 F7     726          MMV     @R1,A
0444 08     727          INC     R0
0445 09     728          INC     R1
0446 DAFA   729          DJNZ    R2,TRANSFER_LOOP
0448 D200   730          SETB    POS_UPDATED             ;Indicate that a valid GPGGA message was rcvd
044A 75230A 731          MOV     SS_WDT,#GPS_TIME        ;and reinit timer
044D 30030D 732          JNB     NON_ZERO_POS,DO_NOT_TRANSFER ;Jump if no non-zero pos digits rcvd
0450 D202   733          SETB    FIRST_POS_RCVD  ;Tell main loop to start transmitting position
0452 200410 734          JB      LEAVE_LED_ON,RETURN_FROM_SERIAL_ISR ;Jump if RTU STATUS LED already on
            735  GOOD_POSITION_STATUS:
0455 C290   736          CLR     nSTATUS         ;Else turn on RTU STATUS LED
0457 7527C8 737          MOV     STATUS_LED_TICK,#200    ;Init TIMER0 ISR counter for 200ms
045A 020465 738          JMP     RETURN_FROM_SERIAL_ISR
            739  DO_NOT_TRANSFER:
045D 200405 740          JB      LEAVE_LED_ON,RETURN_FROM_SERIAL_ISR ;Jump if RTU STATUS LED already on
            741  NO_POSITION_STATUS:
0460 C290   742          CLR     nSTATUS         ;Else turn on RTU STATUS LED
0462 752732 743          MOV     STATUS_LED_TICK,#50     ;Init TIMER0 ISR counter for 50ms
            744  RETURN_FROM_SERIAL_ISR:
0465 D0E0   745          POP     ACC
0467 D0D0   746          POP     PSW                     ;Restore PSW
0469 32     747          RETI
            748
            749  ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
            750
            751  ;                                       SUBROUTINES
            752
            753  ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
            754  ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
            755
            756  ;                                       PLAY_USER_MESSAGE
```

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                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                PLAY_USER_MESSAGE:
046A C0E0               PUSH    ACC                     ;Save used registers
046C C0D0               PUSH    PSW
                PU_VRPD_FOR_UDM_PLAYBACK:
046E C2A0               CLR     PD                      ;Power up VRPDs (U3) for user message
0470 752523             MOV     MSEC,#PUD_TIME
0473 120560             CALL    DLY_MSEC
0476 D2A7               SETB    P_r                     ;Select VRPD playback mode
0478 C291               CLR     F_u                     ;Select direct address for user message
047A D2A3               SETB    A0
047C D2A4               SETB    A4
047E C2A6               CLR     nCEU3                   ;Else latch address and begin playback
0480 D2A6               SETB    nCEU3
0482 D204               SETB    LEAVE_LED_ON
0484 C290               CLR     nSTATUS                 ;Turn on RTU STATUS LED
0486 2094FD             JB      nEOM_U3,$               ;Loop until U3's EOM is asserted
0489 752511             MOV     MSEC,#EOM_TIME          ;Wait until end of message
048C 120560             CALL    DLY_MSEC
                END_USER_MESSAGE_PLAYBACK:
048F D290               SETB    nSTATUS                 ;Turn off RTU STATUS LED
0491 C204               CLR     LEAVE_LED_ON
0493 D291               SETB    F_u                     ;Re-select fixed VRPD addresses
0495 D2A0               SETB    PD                      ;Power down VRPDs
0497 D0D0               POP     PSW                     ;Restore used registers
0499 D0E0               POP     ACC
049B 22                 RET

                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS

                ;                                       FLICKER_STATUS_LED
                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                FLICKER_STATUS_LED:
049C 7E03               MOV     R6,#3
                FLICKER_LOOP:
049E C290               CLR     nSTATUS
04A0 1205D3             CALL    DLY_P1S
04A3 D290               SETB    nSTATUS
04A5 1205D3             CALL    DLY_P1S
04A8 DEF4               DJNZ    R6,FLICKER_LOOP
04AA 22                 RET

                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS

                ;                                       PLAY_MESSAGE
                ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                PLAY_MESSAGE:
04AB 75220A             MOV     WDT,#10                 ;Allow 10 seconds for playback of message
04AE E529               MOV     A,MESSAGE               ;A gets message number
04B0 23                 RL      A                       ;Multiply by 2 (2 bytes per table entry)
04B1 240D               ADD     A,#13                   ;13 bytes to first MESSAGE_TABLE pointer entry
04B3 83                 MOVC    A,@A+PC                 ;A gets first byte of table entry
04B4 F52A               MOV     VRPD_MSG_PTR,A  ;(2) Save looked up message pointer
04B6 E529               MOV     A,MESSAGE               ;(2) A gets message number
04B8 23                 RL      A                       ;(1) Multiply by 2 (2 bytes per table entry)
04B9 2406               ADD     A,#6                    ;(2) 5+1 bytes to first MESSAGE_TABLE device entry
04BB 83                 MOVC    A,@A+PC                 ;(1) A gets second byte of table entry
04BC F52B               MOV     VRPD,A                  ;(2) Save looked up device number
04BE 0204F7             LJMP    INIT_VRPD               ;(3) Jump to set up appropriate VRPD per table

                MESSAGE_TABLE:
04C1 00         ZEERO:          DB      00h,2   ;Message #00h
```

```
04C2 02
04C3 01          821    ONE:          DB      01h,2   ;  "    #01h
04C4 02
04C5 02          822    TWO:          DB      02h,2   ;  "    #02h
04C6 02
04C7 03          823    THREE:        DB      03h,2   ;  "    #03h
04C8 02
04C9 04          824    FOUR:         DB      04h,2   ;  "    #04h
04CA 02
04CB 05          825    FIFE:         DB      05h,2   ;  "    #05h
04CC 02
04CD 06          826    SIX:          DB      06h,2   ;  "    #06h
04CE 02
04CF 07          827    SEVEN:        DB      07h,2   ;  "    #07h
04D0 02
04D1 08          828    EIGHT:        DB      08h,2   ;  "    #08h
04D2 02
04D3 09          829    NINER:        DB      09h,2   ;  "    #09h
04D4 02
04D5 0A          830    NORTH:        DB      0Ah,2   ;  "    #0Ah
04D6 02
04D7 0B          831    SOUTH:        DB      0Bh,2   ;  "    #0Bh
04D8 02
04D9 0C          832    EAST:         DB      0Ch,2   ;  "    #0Ch
04DA 02
04DB 0D          833    WEST:         DB      0Dh,2   ;  "    #0Dh
04DC 02
04DD 0E          834    TARGET:       DB      0Eh,2   ;  "    #0Eh
04DE 02
04DF 0F          835    POINT:        DB      0Fh,2   ;  "    #0Fh
04E0 02
04E1 10          836    LAST:         DB      10h,2   ;  "    #10h
04E2 02
04E3 00          837    LONGITUDE:    DB      00h,3   ;  "    #11h
04E4 03
04E5 01          838    LATITUDE:     DB      01h,3   ;  "    #12h
04E6 03
04E7 02          839    POSITION:     DB      02h,3   ;  "    #13h
04E8 03
04E9 03          840    RESET_MSG:    DB      03h,3   ;  "    #14h
04EA 03
04EB 04          841    ALERT_TONES:  DB      04h,3   ;  "    #15h
04EC 03
04ED 05          842    NO_GPS:       DB      05h,3   ;  "    #16h
04EE 03
04EF 06          843    A_IS:         DB      06h,3   ;  "    #17h
04F0 03
04F1 07          844    B_IS:         DB      07h,3   ;  "    #18h
04F2 03
04F3 08          845    DEGREES:      DB      08h,3   ;  "    #19h
04F4 03
04F5 09          846    MINUTES:      DB      09h,3   ;  "    #1Ah
04F6 03
                 847
                 848    INIT_VRPD:
04F7 C2A3        849          CLR     A0              ;Assume no message cueing required
04F9 D2A4        850          SETB    A4              ;Select consecutive address mode
04FB D2A0        851          SETB    PD              ;Reset both VRPD message pointers
04FD C2A0        852          CLR     PD
04FF 752523      853          MOV     MSEC,#PUD_TIME
0502 120560      854          CALL    DLY_MSEC        ;Allow for VRPD 25ms power-up delay
0505 E52B        855          MOV     A,VRPD          ;A gets device number (2=U2, 3=U3)
0507 B4022B      856          CJNE    A,#2,CUE_U3     ;Jump if message not stored in VRPD U2
                 857    CUE_U2:
```

```
050A E52A        858            MOV     A,VRPD_MSG_PTR  ;A gets message pointer
050C 6018        859            JZ      PLAY_U2                 ;Jump if ptr = 0 (no message cueing required)
050E FD          860            MOV     R5,A                    ;Else R5=A=number of cues (fast forwards) required
050F D2A3        861            SETB    A0                      ;Enable message cueing mode
                 862    ASSERT_U2_CE:
0511 C2AF        863            CLR     EA                      ;Disable all interrupts during 10us cueing strobe
0513 C2A5        864            CLR     nCEU2                   ;Else enable U2 and latch cueing and consec mode
0515 D2A5        865            SETB    nCEU2
0517 D2AF        866            SETB    EA                      ;Re-enable all interrupts
                 867    ;       JB      nEOM_U2,$               ;Loop until nEOM_U2 lowers
0519 752511      868            MOV     MSEC,#EOM_TIME
051C 120560      869            CALL    DLY_MSEC        ;Allow for inter-End-Of-Message delay
051F 3095FD      870            JNB     nEOM_U2,$               ;Make sure EOM has risen
0522 DDED        871            DJNZ    R5,ASSERT_U2_CE ;Loop until cued to desired message
0524 C2A3        872            CLR     A0                      ;Disable message cueing
                 873    PLAY_U2:
0526 C2A5        874            CLR     nCEU2                   ;Initiate playback of selected message
0528 D2A5        875            SETB    nCEU2
052A C290        876            CLR     nSTATUS                 ;Turn on RTU STATUS LED
052C 2095FD      877            JB      nEOM_U2,$               ;Loop until EOM lowers
052F 3095FD      878            JNB     nEOM_U2,$               ;Loop until rising edge of EOM
0532 02055D      879            JMP     RETURN_FROM_PLAY_MESSAGE
                 880
                 881    CUE_U3:
0535 E52A        882            MOV     A,VRPD_MSG_PTR  ;A gets message pointer
0537 6018        883            JZ      PLAY_U3                 ;Jump if ptr = 0 (no message cueing required)
0539 FD          884            MOV     R5,A                    ;Else R5=A=number of cues (fast forwards) required
053A D2A3        885            SETB    A0                      ;Enable message cueing mode
                 886    ASSERT_U3_CE:
053C C2AF        887            CLR     EA                      ;Disable all interrupts during 10us cueing strobe
053E C2A6        888            CLR     nCEU3                   ;Else enable U3 and latch cueing and consec mode
0540 D2A6        889            SETB    nCEU3
0542 D2AF        890            SETB    EA                      ;Re-enable all interrupts
                 891    ;       JB      nEOM_U3,$               ;Loop until nEOM_U3 lowers
0544 752511      892            MOV     MSEC,#EOM_TIME
0547 120560      893            CALL    DLY_MSEC        ;Allow for inter-End-Of-Message delay
054A 3094FD      894            JNB     nEOM_U3,$               ;Make sure EOM has risen
054D DDED        895            DJNZ    R5,ASSERT_U3_CE ;Loop until cued to desired message
054F C2A3        896            CLR     A0                      ;Disable message cueing
                 897    PLAY_U3:
0551 C2A6        898            CLR     nCEU3                   ;Initiate playback of selected message
0553 D2A6        899            SETB    nCEU3
0555 C290        900            CLR     nSTATUS                 ;Turn on RTU STATUS LED
0557 2094FD      901            JB      nEOM_U3,$               ;Loop until EOM lowers
055A 3094FD      902            JNB     nEOM_U3,$               ;Loop until rising edge of EOM
                 903    RETURN_FRGM_PLAY_MESSAGE:
055D D290        904            SETB    nSTATUS                 ;Turn off RTU STATUS LED
055F 22          905            RET
                 906
                 907    ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                 908    ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                 909
                 910    ;                                               DLY_ MSEC
                 911    ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                 912    DLY_MSEC:
0560 C0E0        913            PUSH    ACC
0562 C0D0        914            PUSH    PSW
0564 752600      915            MOV     ONE_MS_TICK,#0
                 916    DLY MSEC LOOP:
                 917    _       MOV     A,ONE_MS_TICK
0567 E526        918            CLR     CY
0569 C2D7        919            SUBB    A,MSEC
056B 9525        920            JC      DLY_MSEC_LOOP
056D 40F8        921            POP     PSW
056F D0D0
```

```
0571 D0E0               922             POP     ACC
0573 22                 923             RET
                        924
                        925     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        926     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        927
                        928     ;                                       XMTR_ON
                        929     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        930     XMTR_ON:
0574 208717             931             JB      XPWR,RETURN_FROM_XMTR_ON ;Jump if xmtr relay already latched on
0577 C293               932             CLR     nXON                    ;Else energize xmtr relay's RESET coil
0579 1205D3             933             CALL    DLY_P1S                 ;Allow 0.1 sec for contact closure & latching
057C D293               934             SETB    nXON                    ;De-energize xmtr relay's RESET coil
057E 1205DC             935             CALL    DLY_P5S                 ;Allow 0.5 sec for xmtr to stabilize
0581 20870A             936             JB      XPWR,RETURN_FROM_XMTR_ON ;Jump if first attempt was successful
0584 C293               937             CLR     nXON                    ;Else re-energize xmtr relay's RESET coil
0586 1205D3             938             CALL    DLY_P1S                 ;Allow 0.1 sec for contact closure & latching
0589 D293               939             SETB    nXON                    ;De-energize xmtr relay's RESET coil
058B 1205DC             940             CALL    DLY_P5S                 ;Allow 0.5 sec for xmtr to stabilize
                        941     RETURN_FROM_XMTR_ON:
058E 22                 942             RET                             ;And return
                        943
                        944     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        945
                        946     ;                                       XMTR_OFF
                        947     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        948     XMTR_OFF:
058F 308711             949             JNB     XPWR,RETURN_FROM_XMTR_OFF ;Jump if xmtr relay already latched off
0592 C292               950             CLR     nXOFF                   ;Else energize xmtr relay's SET coil
0594 1205D3             951             CALL    DLY_P1S                 ;Allow 0.1 sec for contact opening & latching
0597 D292               952             SETB    nXOFF                   ;De-energize xmtr relay's SET coil
0599 308707             953             JNB     XPWR,RETURN_FROM_XMTR_OFF ;Jump if first attempt was successful
059C C292               954             CLR     nXOFF                   ;Else energize xmtr relay's SET coil
059E 1205D3             955             CALL    DLY_P1S                 ;Allow 0.1 sec for contact opening & latching
05A1 D292               956             SETB    nXOFF                   ;De-energize xmtr relay's SET coil
                        957     RETURN_FROM_XMTR_OFF:
05A3 22                 958             RET                             ;And return
                        959
                        960     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        961     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        962
                        963     ;                                       INIT_GPS_RCVR
                        964     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        965     INIT_GPS_RCVR:
05A4 C2AC               966             CLR     ES                      ;Disable serial port receive/transmit interrupt
05A6 C299               967             CLR     TI                      ;Clear serial port transmit interrupt flag
05A8 7E0E               968             MOV     R6,#14                  ;Offset by 14 characters between MOVC and message
                        969     INIT_GPS_LOOP:
05AA EE                 970             MOV     A,R6                    ;A = R6 = temporary pointer to message characters
05AB 83                 971             MOVC    A,@A+PC                 ;A = Character @address = (pointer + PC)
05AC F599               972             MOV     SBUF,A                  ;(2) Copy character to serial port Send Buffer
05AE 3099FD             973             JNB     TI,$                    ;(3) Loop until SBUF is ready for next character
05B1 C299               974             CLR     TI                      ;(2) Clear serial port transmit interrupt flag
05B3 0E                 975             INC     R6                      ;(1) Increment character pointer
05B4 BE24F3             976             CJNE    R6,#36,INIT_GPS_LOOP ;(3) Loop until offset = 36 (14+22 chars sent)
05B7 0205D0             977             LJMP    RETURN_FROM_INIT_GPS_RCVR ;(3) Return after 22nd char sent
05BA 24504D47           978     INIT_GPS_MSG:   DB      '$PMGLI,00,B00,2,A,00',0Dh,0Ah
05BE 4C492C30
05C2 302C4230
05C6 302C322C
05CA 412C3030
05CE 0D
05CF 0A
                        979                             ;Starts the GPGGA 'Position and Altitude' GPS msg.
```

```
                        980     RETURN_FROM_INIT_GPS_RCVR:
05D0 D2AC               981             SETB ES                 ;Re-enable serial port receive/transmit interrupt
05D2 22                 982             RET
                        983
                        984     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        985
                        986     ;                                               DLY_P1S
                        987     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        988     DLY_P1S:
05D3 753000             989             MOV     TICK,#0                 ;Clear relative timer
                        990     P1S_LOOP:
05D6 AA30               991             MOV     R2,TICK
05D8 BA02FB             992             CJNE    R2,#2,P1S_LOOP
05DB 22                 993             RET
                        994
                        995     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        996     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                        997
                        998     ;                                               DLY_P5S
                        999     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1000     DLY_P5S:
05DC 753000            1001             MOV     TICK,#0                 ;Clear relative timer
                       1002     P5S_LOOP:
05DF AA30              1003             MOV     R2,TICK
05E1 BA0AFB            1004             CJNE    R2,#10,P5S_LOOP
05E4 22                1005             RET
                       1006
                       1007     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1008     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1009
                       1010     ;                                               DLY_1S
                       1011     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1012     DLY_1S:
05E5 753000            1013             MOV     TICK,#0                 ;Clear relative timer
                       1014     OS_LOOP:
05E8 AA30              1015             MOV     R2,TICK
05EA BA14FB            1016             CJNE    R2,#20,OS_LOOP
05ED 22                1017             RET
                       1018
                       1019     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1020     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1021
                       1022     ;                                               PLAY_R4_TBUF_DIGITS
                       1023     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1024     PLAY_R4_TBUF_DIGITS:
05EE E6                1025             MOV     A,@R0                   ;A gets ASCII digit char from xmit buffer <- R0
05EF C3                1026             CLR     C
05F0 9430              1027             SUBB    A,#30h                  ;Convert from ASCII char to number
05F2 F529              1028             MOV     MESSAGE,A               ;Play the digit
05F4 91AB              1029             CALL    PLAY_MESSAGE
05F6 08                1030             INC     R0                      ;Point to next TBUF character
05F7 DCF5              1031             DJNZ    R4,PLAY_R4_TBUF_DIGITS ;Loop until all digits have been sent
                       1032     ;       CALL    DLY_P5S                 ;Pause between digits
05F9 22                1033             RET
                       1034
                       1035     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1036
                       1037     ;                                               PLAY_TBUF_DIR
                       1038     ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                       1039     PLAY_TBUF_DIR:
05FA E6                1040             MOV     A,@R0
                       1041     NORTH?:
05FB B44E06            1042             CJNE    A,#'N',SOUTH?
05FE 75290A            1043             MOV     MESSAGE,#0Ah
```

```
0601 020619          1044              JMP     SEND_DIR
                     1045      SOUTH?:
0604 B45306          1046              CJNE    A,#'S',EAST?
0607 75290B          1047              MOV     MESSAGE,#0Bh
060A 020619          1048              JMP     SEND_DIR
                     1049      EAST?:
060D B44506          1050              CJNE    A,#'E',WEST?
0610 75290C          1051              MOV     MESSAGE,#0Ch
0613 020619          1052              JMP     SEND_DIR
                     1053      WEST?:
0616 75290D          1054              MOV     MESSAGE,#0Dh            ;WEST is the default direction
                     1055      SEND_DIR:
0619 91AB            1056              CALL    PLAY_MESSAGE
061B 08              1057              INC     R0
                     1058      ;       CALL    DLY_1S
061C 22              1059              RET
                     1060
                     1061      ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                     1062      ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                     1063
                     1064      ;                                               ASCII_TO_REAL
                     1065      ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                     1066      ASCII_TO_REAL:
061D E52D            1067              MOV     A,RCHAR
061F C3              1048              CLR     C
0620 9440            1069              SUBB    A,#40h
0622 E52D            1070              MOV     A,RCHAR
0624 5004            1071              JNC     CHAR_IS_ALPHA
                     1072      CHAR_IS_NUMERIC:
0626 C3              1073              CLR     C
0627 9430            1074              SUBB    A,#30h
0629 22              1075              RET
                     1076      CHAR_IS_ALPHA:
062A C3              1077              CLR     C
062B 9437            1078              SUBB    A,#37h
062D 22              1079              RET
                     1080
                     1081      ;SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS
                     1082      ;BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
                     1083
----                 1084              BSEG                            ;Beginning if Bit Segment
0000                 1085              ORG     00h                     ;... at lowest RAM address above reg banks R0-R3
0000                 1086      POS_UPDATED:    DBIT    1       ;Set by SERIAL_PORT_ISR on good sentence
0001                 1087      STOP_BIT_ERROR: DBIT    1       ; " "   "    "   " " 0 stop bit
0002                 1088      FIRST_POS_RCVD:  DBIT 1 ;Set upon receipt of 1st valid non-zero position
0003                 1089      NON_ZERO_POS:   DBIT 1  ;Set if non-zero position digit received
0004                 1090      LEAVE_LED_ON:   DBIT    1       ;Signals TIMER0 ISR not to turn off STATUS LED
                     1091
----                 1092              DSEG                            ;Beginning of Data Segment
0022                 1093              ORG     22h                     ;Reserve RAM bytes 20-21h of BSEG for flags
0022                 1094      WDT:            DS      1       ;Seconds Watch Dog Timer decremented by TIMER0 ISR
0023                 1095      SS_WDT:         DS      1       ;   "       "   "   "       "       "   "   "
0024                 1096      FIFTY_MS:       DS      1       ;Incremented every 50ms (up to 1 second) by TIMER0 ISR
0025                 1097      MSEC:           DS      1       ;Number of milliseconds to delay in DLY_MSEC routine
0026                 1098      ONE_MS_TICK:    DS      1       ;Changeable relative 1ms counter in TIMER0 ISR
0027                 1099      STATUS_LED_TICK:        DS      1       ;ms countdown for serial ISR status
0028                 1100      PRE_TICK:       DS      1       ;Non-changeable 1ms counter in TIMER0 ISR
0029                 1101      MESSAGE:                DS      1       ;Contains message no. for "PLAY_MESSAGE" routine
002A                 1102      VRPD_MSG_PTR:   DS      1       ;Voice Record Playback Device message pointer
002B                 1103      VRPD:           DS      1       ;2 for U2, 3 for U3
002C                 1104      I_P_TIMER:      DS      1       ;Inter-position message timer, INT0 ISR decrements
002D                 1105      RCHAR:          DS      1       ;Character received from SBUF
002E                 1106      CHECKSUM:       DS      1       ;All characters 'ut "$","*", and CS -> checksum
002F                 1107      RCHAR_CTR:      DS      1       ;No. of characters received after "$"
```

```
0030    TICK:           DS      1       ;Relative counter incr. by TIMERO ISR every 50ms
0031    RBUF_PTR:       DS      1       ;SERIAL_PORT_ISR uses this ptr to fill RBUF

        RBUF_START:
0032    RBUF_LAT_10D:   DS      1       ;Receiver buffer latitude tens of degrees
0033    RBUF_LAT_D:     DS      1       ;  "      "      "      degrees
0034    RBUF_LAT_10M:   DS      1       ;  "      "      "      tens of minutes
0035    RBUF_LAT_M:     DS      1       ;  "      "      "      minutes
0036    RBUF_LAT_P1M:   DS      1       ;  "      "      "      tenths of minutes
0037    RBUF_LAT_P01M:  DS      1       ;  "      "      "      hundredths of minutes
0038    RBUF_LAT_DIR:   DS      1       ;  "      "      "      (N)orth or (S)outh

0039    RBUF_LONG_100D: DS      1       ;  "      "   longitude hundreds of degrees
003A    RBUF_LONG_10D:  DS      1       ;  "      "      "      tens of degrees
003B    RBUF_LONG_D:    DS      1       ;  "      "      "      degrees
003C    RBUF_LONG_10M:  DS      1       ;  "      "      "      tens of minutes
003D    RBUF_LONG_M:    DS      1       ;  "      "      "      minutes
003E    RBUF_LONG_P1M:  DS      1       ;  "      "      "      tenths of minutes
003F    RBUF_LONG_P01M: DS      1       ;  "      "      "      hundredths of minutes
0040    RBUF_LONG_DIR:  DS      1       ;  "      "      "      (E)ast or (W)est

        TBUF_START:
0041    TBUF_LAT_10D:   DS      1       ;Transmit buffer latitude tens of degrees
0042    TBUF_LAT_D:     DS      1       ;  "      "      "      degrees
0043    TBUF_LAT_10M:   DS      1       ;  "      "      "      tens of minutes
0044    TBUF_LAT_M:     DS      1       ;  "      "      "      minutes
0045    TBUF_LAT_P1M:   DS      1       ;  "      "      "      tenths of minutes
0046    TBUF_LAT_P01M:  DS      1       ;  "      "      "      hundredths of minutes
0047    TBUF_LAT_DIR:   DS      1       ;  "      "      "      (N)orth or (S)outh

0048    TBUF_LONG_100D: DS      1       ;  "      "   longitude hundreds of degrees
0049    TBUF_LONG_10D:  DS      1       ;  "      "      "      tens of degrees
004A    TBUF_LONG_D:    DS      1       ;  "      "      "      degrees
004B    TBUF_LONG_10M:  DS      1       ;  "      "      "      tens of minutes
004C    TBUF_LONG_M:    DS      1       ;  "      "      "      minutes
004D    TBUF_LONG_P1M:  DS      1       ;  "      "      "      tenths of minutes
004E    TBUF_LONG_P01M: DS      1       ;  "      "      "      hundredths of minutes
004F    TBUF_LONG_DIR:  DS      1       ;  "      "      "      (E)ast or (W)est

        ;DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD

                END                     ;End of TGLS4.ASM^
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SYMBOL TABLE LISTING
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N A M E                    T Y P E   V A L U E     A T T R I B U T E S

A_IS . . . . . . . . . . . . C ADDR   04EFH   A
A0 . . . . . . . . . . . . . B ADDR   00A0H.3 A
A4 . . . . . . . . . . . . . B ADDR   00A0H.4 A
ACC. . . . . . . . . . . . . D ADDR   00E0H   A
ALERT_TONES. . . . . . . . . C ADDR   04EBH   A
ANNOUNCE_RESET . . . . . . . C ADDR   008BH   A
ASCII_TO_REAL. . . . . . . . C ADDR   061DH   A
ASSERT_U2_CE . . . . . . . . C ADDR   0511H   A
ASSERT_U3_CE . . . . . . . . C ADDR   053CH   A
B_IS . . . . . . . . . . . . C ADDR   04F1H   A
BAUD_9600. . . . . . . . . .   NUMB   00FDH   A
BEGIN. . . . . . . . . . . . C ADDR   0000H   A
```

```
BUF_LENGTH . . . . . .   NUMB   000EH   A
CHAR_IS_ALPHA. . . . . .  C ADDR   062AH   A
CHAR_IS_NUMERIC. . . . . .  C ADDR   0626H   A
CHECK_FOR_1000MS . . . . .  C ADDR   0339H   A
CHECK_FOR_300MS. . . . . .  C ADDR   0317H   A
CHECK_FOR_500MS. . . . . .  C ADDR   032BH   A
CHECK_FOR_700MS. . . . . .  C ADDR   0321H   A
CHECK_FOR_MESSAGE_TEST . .  C ADDR   00ACH   A
CHECK_FOR_RECORD_MODE. . .  C ADDR   0084H   A
CHECK_GPS_STATUS . . . . .  C ADDR   01B2H   A
CHECK_GPSO . . . . . .  C ADDR   026DH   A
CHECK_I_P_TIMER. . . . . .  C ADDR   027BH   A
CHECK_OVERFLOW_LOOP. . . .  C ADDR   02ADH   A
CHECK_REL_TIMERS . . . . .  C ADDR   02F2H   A
CHECK_STATUS_LED_TICK. . .  C ADDR   02E9H   A
CHECK_STATUS_LED . . . . .  C ADDR   02E0H   A
CHECK_VEHICLE_ID . . . . .  C ADDR   00E5H   A
CHECK_WDT. . . . . .  C ADDR   0313H   A
CHECKSUM . . . . . .  D ADDR   002EH   A
CLEAR_BUF_LOOP . . . . . .  C ADDR   004FH   A
CUE_U2 . . . . . .  C ADDR   050AH   A
CUE_U3 . . . . . .  C ADDR   0535H   A
CY . . . . . .  B ADDR   00D0H.7 A
DEGREES. . . . . .  C ADDR   04F3H   A
DLY_1S . . . . . .  C ADDR   05E5H   A
DLY_MSEC_LOOP. . . . . .  C ADDR   0567H   A
DLY_MSEC . . . . . .  C ADDR   0560H   A
DLY_P1S. . . . . .  C ADDR   05D3H   A
DLY_P5S. . . . . .  C ADDR   05DCH   A
DO_NOT_TRANSFER. . . . . .  C ADDR   045DH   A
EA . . . . . .  B ADDR   00A8H.7 A
EAST . . . . . .  C ADDR   04D9H   A
EAST?. . . . . .  C ADDR   060DH   A
EIGHT. . . . . .  C ADDR   04D1H   A
ENABLE_HOMING. . . . . .  C ADDR   0279H   A
ENABLE_RECORD_INT1 . . . .  C ADDR   0266H   A
END_USER_MESSAGE_PLAYBACK.  C ADDR   048FH   A
END_USER_MESSAGE_RECORDING  C ADDR   02B3H   A
EOM_TIME . . . . . .    NUMB   0011H   A
ES . . . . . .  B ADDR   00A8H.4 A
EX1. . . . . .  B ADDR   00A8H.2 A
F_U. . . . . .  B ADDR   0090H.1 A
FIFE . . . . . .  C ADDR   04CBH   A
FIFTY_MS . . . . . .  D ADDR   0024H   A
FIRST_POS_RCVD . . . . . .  B ADDR   0020H.2 A
FLASH_STATUS_LED . . . . .  C ADDR   00DCH   A
FLICKER_LOOP . . . . . .  C ADDR   049EH   A
FLICKER_STATUS_LED . . . .  C ADDR   049CH   A
FOUR . . . . . .  C ADDR   04C9H   A
GOOD_POSITION_STATUS . . .  C ADDR   0455H   A
GPS_ONLY . . . . . .  C ADDR   0270H   A
GPS_TIME . . . . . .    NUMB   000AH   A
GPS_WDT_TIMEOUT_LOOP . . .  C ADDR   008EH   A
H_G. . . . . .  B ADDR   00B0H.4 A
I_P_TIME . . . . . .    NUMB   0078H   A
I_P_TIMER. . . . . .  D ADDR   002CH   A
IE . . . . . .  D ADDR   00A8H   A
IE1. . . . . .  B ADDR   0088H.3 A
INIT_GPS_LOOP. . . . . .  C ADDR   05AAH   A
INIT_GPS_MSG . . . . . .  C ADDR   05BAH   A
INIT_GPS_RCVR. . . . . .  C ADDR   05A4H   A
INIT_INTER_POS_TIMER . . .  C ADDR   0196H   A
INIT_VRPD. . . . . .  C ADDR   04F7H   A
INIT . . . . . .  C ADDR   0026H   A
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INITIALIZE_GPS_RCVR. . . .  C ADDR    007EH   A
INITIALIZE_REGISTERS . . .  C ADDR    0057H   A
INITIALIZE_STATUS_FLAGS. .  C ADDR    0072H   A
INT0_ISR . . . . . .  C ADDR    0287H   A
INT1_ISR . . . . . .  C ADDR    028EH   A
IP . . . . . .  D ADDR    00B8H   A
IT1. . . . . .  B ADDR    0088H.2 A
J_POWER_UP_VRPD. . . . . .  C ADDR    0285H   A
J_POWER_UP_XMTR. . . . . .  C ADDR    00FDH   A
LAST . . . . . .  C ADDR    04E1H   A
LATITUDE . . . . . .  C ADDR    04E5H   A
LEAVE_LED_ON . . . . . .  B ADDR    0020H.4 A
LONGITUDE. . . . . .  C ADDR    04E3H   A
LOOK_UP_RESPONSE . . . . .  C ADDR    0373H   A
MESSAGE_MAX. . . . . .    NUMB    001AH   A
MESSAGE_TABLE. . . . . .  C ADDR    04C1H   A
MESSAGE. . . . . .  D ADDR    0029H   A
MINUTES. . . . . .  C ADDR    04F5H   A
MSEC . . . . . .  D ADDR    0025H   A
NCEU2. . . . . .  B ADDR    00A0H.5 A
NCEU3. . . . . .  B ADDR    00A0H.6 A
NEOM_U2. . . . . .  B ADDR    0090H.5 A
NEOM_U3. . . . . .  B ADDR    0090H.4 A
NGPSO. . . . . .  B ADDR    0080H.0 A
NINER. . . . . .  C ADDR    04D3H   A
NO_GPS . . . . . .  C ADDR    04EDH   A
NO_POSITION_STATUS . . . .  C ADDR    0460H   A
NON_ZERO_POS . . . . . .  B ADDR    0020H.3 A
NORTH. . . . . .  C ADDR    04D5H   A
NORTH? . . . . . .  C ADDR    05FBH   A
NREC . . . . . .  B ADDR    00B0H.3 A
NSIGA. . . . . .  B ADDR    00A0H.1 A
NSIGB. . . . . .  B ADDR    00A0H.2 A
NSTATUS. . . . . .  B ADDR    0090H.0 A
NVID1. . . . . .  B ADDR    0080H.1 A
NVID2. . . . . .  B ADDR    0080H.2 A
NVID4. . . . . .  B ADDR    0080H.3 A
NXOFF. . . . . .  B ADDR    0090H.2 A
NXON . . . . . .  B ADDR    0090H.3 A
ONE_HZ . . . . . .  B ADDR    00B0H.2 A
ONE_MS_TICK. . . . . .  D ADDR    0026H   A
ONE. . . . . .  C ADDR    04C3H   A
OS_LOOP. . . . . .  C ADDR    05E8H   A
P_R. . . . . .  B ADDR    00A0H.7 A
P001_SEC_HI. . . . . .    NUMB    00FCH   A
P001_SEC_LO. . . . . .    NUMB    0066H   A
P0 . . . . . .  D ADDR    0080H   A
P1 . . . . . .  D ADDR    0090H   A
P1S_LOOP . . . . . .  C ADDR    05D6H   A
P2 . . . . . .  D ADDR    00A0H   A
P3 . . . . . .  D ADDR    00B0H   A
P5S_LOOP . . . . . .  C ADDR    05DFH   A
PCON . . . . . .    NUMB    0087H   A
PD . . . . . .  B ADDR    00A0H.0 A
PLAY_MESSAGE . . . . . .  C ADDR    04ABH   A
PLAY_R4_TBUF_DIGITS. . . .  C ADDR    05EEH   A
PLAY_TBUF_DIR. . . . . .  C ADDR    05FAH   A
PLAY_U2. . . . . .  C ADDR    0526H   A
PLAY_U3. . . . . .  C ADDR    0551H   A
PLAY_USER_MESSAGE. . . . .  C ADDR    046AH   A
POINT. . . . . .  C ADDR    04DFH   A
POS_UPDATED. . . . . .  B ADDR    0020H.0 A
POSITION . . . . . .  C ADDR    04E7H   A
POWER_DOWN_8751. . . . . .  C ADDR    0273H   A
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POWER_DOWN_VRPD. . . . . C ADDR    0262H   A
POWER_UP_VRPD. . . . . . C ADDR    00CAH   A
POWER_UP_XMTR. . . . . . C ADDR    018FH   A
PRE_TICK . . . . . . . . D ADDR    0028H   A
PREPARE_TO_RECORD. . . . . C ADDR  0100H   A
PSW. . . . . . . . . . . . D ADDR  00D0H   A
PU_VRPD_FOR_UDM_PLAYBACK . C ADDR  046EH   A
PU_VRPD_FOR_UDM. . . . . . C ADDR  0297H   A
PUD_TIME . . . . . . . . .   NUMB  0023H   A
RB8. . . . . . . . . . . . B ADDR  0098H.2 A
RBUF_LAT_10D . . . . . . . D ADDR  0032H   A
RBUF_LAT_10M . . . . . . . D ADDR  0034H   A
RBUF_LAT_D . . . . . . . . D ADDR  0033H   A
RBUF_LAT_DIR . . . . . . . D ADDR  0038H   A
RBUF_LAT_M . . . . . . . . D ADDR  0035H   A
RBUF_LAT_P01M. . . . . . . D ADDR  0037H   A
RBUF_LAT_P1M . . . . . . . D ADDR  0036H   A
RBUF_LONG_100D . . . . . . D ADDR  0039H   A
RBUF_LONG_10D. . . . . . . D ADDR  003AH   A
RBUF_LONG_10M. . . . . . . D ADDR  003CH   A
RBUF_LONG_D. . . . . . . . D ADDR  003BH   A
RBUF_LONG_DIR. . . . . . . D ADDR  0040H   A
RBUF_LONG_M. . . . . . . . D ADDR  003DH   A
RBUF_LONG_P01M . . . . . . D ADDR  003FH   A
RBUF_LONG_P1M. . . . . . . D ADDR  003EH   A
RBUF_PTR . . . . . . . . . D ADDR  0031H   A
RBUF_START . . . . . . . . D ADDR  0032H   A
RCHAR_CTR_OK . . . . . . . C ADDR  0381H   A
RCHAR_CTR. . . . . . . . . D ADDR  002FH   A
RCHAR_EQ_0 . . . . . . . . C ADDR  0404H   A
RCHAR. . . . . . . . . . . D ADDR  002DH   A
RECORD_U2_LOOP . . . . . . C ADDR  0126H   A
RECORD_U2_MESSAGES . . . . C ADDR  0113H   A
RECORD_U3_LOOP . . . . . . C ADDR  0163H   A
RECORD_U3_MESSAGES . . . . C ADDR  0150H   A
RESET_MSG. . . . . . . . . C ADDR  04E9H   A
RESPOND_TO_1 . . . . . . . C ADDR  03CFH   A
RESPOND_TO_2 . . . . . . . C ADDR  03DDH   A
RESPOND_TO_3 . . . . . . . C ADDR  03EBH   A
RESPOND_TO_4 . . . . . . . C ADDR  0409H   A
RESPOND_TO_5 . . . . . . . C ADDR  041DH   A
RESPOND_TO_6 . . . . . . . C ADDR  0425H   A
RESPOND_TO_7 . . . . . . . C ADDR  0432H   A
RESPOND. . . . . . . . . . C ADDR  03C4H   A
RESPONSE_TABLE . . . . . . C ADDR  0389H   A
RESUME_MAIN_LOOP . . . . . C ADDR  0276H   A
RETURN_FROM_INIT_GPS_RCVR. C ADDR  05D0H   A
RETURN_FROM_PLAY_MESSAGE . C ADDR  055DH   A
RETURN_FROM_SERIAL_ISR . . C ADDR  0465H   A
RETURN_FROM_TIMER0_ISR . . C ADDR  0340H   A
RETURN_FROM_XMTR_OFF . . . C ADDR  05A3H   A
RETURN_FROM_XMTR_ON. . . . C ADDR  058EH   A
RI . . . . . . . . . . . . B ADDR  0098H.0 A
RXDTA. . . . . . . . . . . B ADDR  00B0H.1 A
SBUF . . . . . . . . . . . D ADDR  0099H   A
SCON . . . . . . . . . . . D ADDR  0098H   A
SEND_A_B . . . . . . . . . C ADDR  0235H   A
SEND_A . . . . . . . . . . C ADDR  0244H   A
SEND_ALERT_TONE. . . . . . C ADDR  0199H   A
SEND_B . . . . . . . . . . C ADDR  0259H   A
SEND_DIR . . . . . . . . . C ADDR  0619H   A
SEND_NEW_POSITION. . . . . C ADDR  01D0H   A
SEND_POSITION. . . . . . . C ADDR  01C7H   A
SEND_UDM . . . . . . . . . C ADDR  025FH   A
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SEND_VEHICLE_ID. . . . . C ADDR   019FH   A
SERIAL_PORT_ISR. . . . . C ADDR   0345H   A
SEVEN. . . . . C ADDR   04CFH   A
SIX. . . . . C ADDR   04CDH   A
SOUTH. . . . . C ADDR   04D7H   A
SOUTH? . . . . . C ADDR   0604H   A
SP . . . . . D ADDR   0081H   A
SS_WDT . . . . . D ADDR   0023H   A
STATUS_LED_TICK. . . . . D ADDR   0027H   A
STOP_BIT_ERROR . . . . . B ADDR   0020H.1 A
STOP_BIT_OK. . . . . C ADDR   035CH   A
STOP_U2_RECORDING. . . . C ADDR   0133H   A
STOP_U3_RECORDING. . . . C ADDR   0170H   A
TARGET . . . . . C ADDR   04DDH   A
TBUF_LAT_10D . . . . . D ADDR   0041H   A
TBUF_LAT_10M . . . . . D ADDR   0043H   A
TBUF_LAT_D . . . . . D ADDR   0042H   A
TBUF_LAT_DIR . . . . . D ADDR   0047H   A
TBUF_LAT_M . . . . . D ADDR   0044H   A
TBUF_LAT_P01M. . . . . D ADDR   0046H   A
TBUF_LAT_P1M . . . . . D ADDR   0045H   A
TBUF_LONG_100D . . . . . D ADDR   0048H   A
TBUF_LONG_10D. . . . . D ADDR   0049H   A
TBUF_LONG_10M. . . . . D ADDR   004BH   A
TBUF_LONG_D. . . . . D ADDR   004AH   A
TBUF_LONG_DIR. . . . . D ADDR   004FH   A
TBUF_LONG_M. . . . . D ADDR   004CH   A
TBUF_LONG_P01M . . . . . D ADDR   004EH   A
TBUF_LONG_P1M. . . . . D ADDR   004DH   A
TBUF_START . . . . . D ADDR   0041H   A
TCON . . . . . D ADDR   0088H   A
TEST_ALL_MESSAGES. . . . C ADDR   00AFH   A
TEST_MESSAGE_LOOP. . . . C ADDR   00BBH   A
TH0. . . . . D ADDR   008CH   A
TH1. . . . . D ADDR   008DH   A
THREE. . . . . C ADDR   04C7H   A
TI . . . . . B ADDR   0098H.1 A
TICK . . . . . D ADDR   0030H   A
TIMER0_ISR . . . . . C ADDR   02D2H   A
TL0. . . . . D ADDR   008AH   A
TL1. . . . . D ADDR   008BH   A
TMEN . . . . . B ADDR   0080H.4 A
TMOD . . . . . D ADDR   0089H   A
TR0. . . . . B ADDR   0088H.4 A
TRANSFER_LOOP. . . . . C ADDR   0442H   A
TRANSFER . . . . . C ADDR   043CH   A
TWO. . . . . C ADDR   04C5H   A
TXDTA. . . . . B ADDR   00B0H.0 A
U2_RECORD_OVERFLOW . . . . C ADDR   012CH   A
U3_RECORD_OVERFLOW . . . . C ADDR   0169H   A
VRPD_MSG_PTR . . . . . D ADDR   002AH   A
VRPD . . . . . D ADDR   002BH   A
WD_RST . . . . . B ADDR   0090H.6 A
WDT. . . . . D ADDR   0022H   A
WEST . . . . . C ADDR   04DBH   A
WEST?. . . . . C ADDR   0616H   A
WRITE_PROTECT_CHECK. . . . C ADDR   00F1H   A
XMTR_OFF . . . . . C ADDR   058FH   A
XMTR_ON. . . . . C ADDR   0574H   A
XPWR . . . . . B ADDR   0080H.7 A
ZEERO. . . . . C ADDR   04C1H   A

REGISTER BANK(S) USED: 0
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What is claimed is:

1. An audio information system for determining a present location, said audio information system comprising:

a global position system receiver for providing electrical signals representative of a plurality of ASCII data characters, said ASCII data characters including latitude and longitude spherical coordinates indicative of the present location of said global position system receiver;

a microprocessor coupled to said global position system receiver for receiving said plurality of ASCII data characters, said microprocessor, responsive to said plurality of ASCII characters, generating a voice playback signal and a logic signal having a first logic state and a second logic state;

a voice recorder/playback circuit coupled to said microprocessor, said voice recorder/playback circuit having a message table comprising a plurality of position indicating words;

said voice recorder/playback circuit, responsive to said voice playback signal, sequencing a predetermined number of said plurality of position indicating words to form a position message signal, said position message signal including said latitude and longitude spherical coordinates;

a programmed crystal oscillator for generating a square wave signal having a first predetermined frequency;

a sinewave oscillator having an input connected to said programmed crystal oscillator for receiving said square wave signal and an output, said sinewave oscillator, responsive to said square wave signal, generating a modulated sinewave signal having a second predetermined frequency;

a demultiplexer having a first input connected to the output of said sinewave oscillator for receiving said modulated sinewave signal, a second input connected to said microprocessor for receiving said logic signal and a third input connected to said voice recorder/playback circuit for receiving said position message signal;

said demultiplexer passing said position message signal to the output of said demultiplexer when said logic signal is at said first logic state;

said demultiplexer passing said modulated sinewave signal to the output of said demultiplexer when said logic signal is at said second logic state;

a transmitter having an input connected to the output of said demultiplexer for receiving said position message signal when said logic signal is at said first logic state and said modulated sinewave signal when said logic signal is at said second logic state;

said transmitter having an antenna, said antenna transmitting said position message signal at a third predetermined frequency when said logic signal is at said first logic state, said position message signal providing an indication of the present location of said global position system receiver;

said antenna transmitting said modulated sinewave signal when said logic signal is at said second logic state; and

a speaker coupled to said voice recorder/playback circuit for receiving said position message signal, said speaker, responsive to said position message signal, broadcasting an oral voice report, said oral voice report including said latitude and longitude spherical coordinates indicative of the present location of said global position system receiver.

2. The audio information apparatus of claim 1 wherein said third predetermined frequency is a radio frequency between about 150 kilohertz and 3000 gigahertz.

3. The audio information apparatus of claim 1 further comprising:

an inverter having an input connected to said microprocessor and an output; and

a light emitting diode connected to the output of said inverter.

4. The audio information system of claim 1 wherein said second predetermined frequency is about one kilohertz.

5. The audio information system of claim 1 wherein said plurality of ASCII data characters comprises fifty nine ASCII data characters.

6. The audio information apparatus of claim 1 wherein each of said latitude and longitude spherical coordinates broadcast by said speaker has a direction, said direction being north or south for each of said latitude spherical coordinates and east or west for each of said longitude spherical coordinates.

7. The audio information system of claim 1 wherein said first predetermined frequency is about one hertz.

8. An audio information system for determining a present location, said audio information system comprising:

a global position system receiver for providing electrical signals representative of a plurality of ASCII data characters, said ASCII data characters including latitude and longitude spherical coordinates indicative of the present location of said global position system receiver;

a microprocessor coupled to said global position system receiver for receiving said plurality of ASCII data characters, said microprocessor, responsive to said plurality of ASCII characters, generating a voice playback signal, a transmitter on signal, a transmitter off signal and a logic signal having a first logic state and a second logic state;

a voice recorder/playback circuit coupled to said microprocessor, said voice recorder/playback circuit having a message table comprising a plurality of position indicating words;

said voice recorder/playback circuit, responsive to said voice playback signal, sequencing a predetermined number of said plurality of position indicating words to form a position message signal, said position message signal including said latitude and longitude spherical coordinates;

a programmed crystal oscillator for generating a square wave signal having a first predetermined frequency;

a sinewave oscillator having an input connected to said programmed crystal oscillator for receiving said square wave signal and an output, said sinewave oscillator, responsive to said square wave signal, generating a modulated sinewave signal having a second predetermined frequency;

a demultiplexer having a first input connected to the output of said sinewave oscillator for receiving said modulated sinewave signal, a second input connected to said microprocessor for receiving said logic signal and a third input connected to said voice recorder/playback circuit for receiving said position message signal;

said demultiplexer passing said position message signal to the output of said demultiplexer when said logic signal is at said first logic state;

said demultiplexer passing said modulated sinewave signal to the output of said demultiplexer when said logic signal is at said second logic state;

a transmitter having a first input connected to the output of said demultiplexer for receiving said position message signal when said logic signal is at said first logic state and said modulated sinewave signal when said logic signal is at said second logic state;

said transmitter having an antenna, said antenna transmitting said position message signal at a third predetermined frequency when said logic signal is at said first logic state, said position message signal providing an indication of the present location of said global position system receiver;

said antenna transmitting said modulated sinewave signal when said logic signal is at said second logic state;

relay means connected to said microprocessor for receiving said transmitter on signal and said transmitter off signal, said relay means being coupled to said transmitter, said relay means responsive to said transmitter on signal providing a direct current voltage signal to said transmitter turning on said transmitter allowing said antenna to transmit said position message signal, said relay means responsive to said transmitter off signal turning off said transmitter by preventing said direct current voltage signal from being supplied to said transmitter; and

a speaker coupled to said voice recorder/playback circuit for receiving said position message signal, said speaker, responsive to said position message signal, broadcasting an oral voice report, said oral voice report including said latitude and longitude spherical coordinates indicative of the present location of said global position system receiver.

9. The audio information apparatus of claim **8** further comprising a normally open record button having a first terminal connected to ground and a second terminal connected to said microprocessor.

10. The audio information apparatus of claim **8** further comprising a microphone connected to said voice recorder/playback circuit.

11. The audio information apparatus of claim **8** wherein said third predetermined frequency is a radio frequency between about 150 kilohertz and 3000 gigahertz.

12. The audio information apparatus of claim **8** wherein said relay means comprises:

a NAND gate having an input connected to said microprocessor for receiving said transmitter on signal, and an output;

an inverter having an input for receiving said transmitter off signal and an output;

a first voltage source for providing said direct current voltage signal;

a second voltage source for providing about plus twelve volts;

a first field effect transistor having a gate connected to the output of said inverter, a source connected to ground and a drain;

a second field effect transistor having a gate connected to the output of said NAND gate, a source connected to ground and a drain; and

a relay having a SET coil, a RESET coil and a contact;

said SET coil of said relay having a first terminal connected to said second voltage source and a second terminal connected to the drain of said first field effect transistor;

said RESET coil of said relay having a first terminal connected to said second voltage source and a second terminal connected to the drain of said second field effect transistor;

said contact of said relay having a first terminal connected to said first voltage source and a second terminal connected to said transmitter.

13. The audio information system of claim **8** wherein said plurality of ASCII data characters comprises fifty nine ASCII data characters.

14. The audio information apparatus of claim **8** wherein each of said latitude and longitude spherical coordinates broadcast by said speaker has a direction, said direction being north or south for each of said latitude spherical coordinates and east or west for each of said longitude spherical coordinates.

15. The audio information system of claim **8** wherein said first predetermined frequency is about one hertz.

16. The audio information system of claim **8** wherein said second predetermined frequency is about one kilohertz.

17. The audio information apparatus of claim **8** further comprising:

an inverter having an input connected to said microprocessor and an output; and

a light emitting diode connected to the output of said inverter.

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